Oil Industry Outlook

Fourth Edition
1988-1992

By Robert J. Beck
Economics Editor
The Oil & Gas Journal

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by Robert J. Beck, Economics Editor, *Oil & Gas Journal*

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Foreword

THE PRICE CRASH OF 1986 and the partial recovery that occurred in 1987 were only the most recent in a series of dramatic events that have exposed the world crude-oil market as a cyclical commodity market. Like many other commodity markets, the market for crude oil can be powerfully influenced, but never captured, by cartels such as OPEC or, previously, the Texas Railroad Commission and the Seven Sisters. It is important that readers of this ***Outlook*** recognize the reasons crude-oil prices are doomed to continue cycling irregularly in the foreseeable future, and those economic fundamentals that set the bounds within which prices can be sustained.

Commodity prices of course reflect the interplay of supply and demand. Even in theory, there are only three ways in which any club or conspiracy can ever set or stabilize the price of a commodity:

(1) Control both supply and demand in such a way that they coincide at the desired price. With petroleum, this is an obvious impossibility.

(2) Control demand with sufficient precision that it always coincides with fluctuating and uncontrollable supply, within the desired range of prices. While this has been the rationale behind certain agricultural price-support programs, they are seldom successful for long; such a strategy is in any event irrelevant to the oil industry.

(3) Control supply with sufficient precision that it always coincides with fluctuating and uncontrollable demand, within the desired range of prices. This was the strategy by which state oil and gas conservation agencies, together with a handful of Majors, were able to impart a measure of stability into crude-oil markets prior to the "OPEC revolution" of the 1970s.

The Inevitability of Cycles

Refinery demand for crude oil at any instant reflects the expected consumption of individual petroleum products, which is unsteady, uncontrollable and unpredictable. Consumption of products such as motor and aircraft fuels or light and heavy heating oils, in turn, fluctuates with the weather and the economy. Demand for industrial fuels also depends, even in the short term, on the prices and availability of coal and natural gas, which are also traded in commodity markets whose cyclical rhythms differ from that of crude oil. Because each of these external circumstances contains an element of randomness and surprise, they frequently generate unplanned or inconvenient accumulations and liquidations of crude-oil and petroleum-product stocks. So, while one *purpose* of inventory movements is to dampen the impact on crude-oil markets of fluctuations in final-product demand, their true *effect* is just as often to worsen the impact of its instability and unpredictability.

From the mid-1930s to the early 1970s, crude-oil markets were effectively insulated from this turmoil. The Texas Railroad Commission and its sister agencies in other producing states programmed oil production on the basis of monthly nominations from refiners. At the same time, virtually all producing capacity outside North America was controlled by a handful of integrated companies, which were therefore enabled to "lift" just about as much crude as their own refineries needed to meet expect-

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ed product demand. "Captive" movements of crude oil thus greatly overshadowed arms-length sales, while spot transactions amounted to a barely visible fraction of the whole. Structured this way, crude-oil markets made it through World War II and three major political crises in the Middle East (1954, 1956, and 1967) without perceived shortages or surpluses and with only occasional ripples in prices.

This system has vanished for ever. State commissions no longer control domestic liftings; U.S. producers are "price-takers" in an integrated world market within which only about one-fifth of the supply (excluding intra-U.S.S.R. movements) now moves in captive channels. Indeed, something on the order of half of the total now trades on essentially "spot" terms, determined impersonally on cash or futures exchanges that nominally center in New York or Rotterdam, but which are in fact phantoms without any address, residing in the global telecommunications network.

Daily and monthly price movements have thus come to echo the hopes, fears and fantasies of traders and speculators, in addition to the anticipated course of petroleum-products consumption, the physical lifting decisions made by producing companies and countries, and planned and unplanned changes in crude-oil and product stocks. In mid-1987, for example, spot and futures prices were able to stay as much as $4 per barrel above official (and, at that time, genuine) OPEC prices, not because there had occurred any cutback in liftings or any unmet surge in product demand, but largely in psychological response to the rising profile of U.S. diplomatic and military blundering in the Gulf War.

Inscrutability of the Long Term

Long-term trends in petroleum-product demand are even more difficult to anticipate with confidence than seasonal, cyclical, or random fluctuations, because they reflect changes in tastes and technologies, in addition to all of the factors that influence short-term movements in consumption. Mistaken expectations that result in under- or overinvestment in producing, refining, and transport capacity likewise have longer-lasting and more profound market effects than errors in inventory management, because of the capital-intensiveness of these assets, the long lead times required for their construction, and their long service lives once built.

There are two long-term constants that have an inescapable impact on crude-oil markets, however, and which industry and government decision-makers have had a regrettable propensity to ignore: The first is that liquid petroleum is a wholly dispensable commodity. And the second is that no producer cartel can be more than a voluntary association of sovereign states, whose viability depends upon the sustained willingness of one or more of its leading members to endure financial sacrifices for the sake of the rest.

Fuel-Substitution as the Cap to Sustainable Oil Prices

The essential needs of industrial society are not for oil or any other primary fuel, but rather for heat, light, motive power, and for simple hydrocarbon building blocks that can be used to fabricate a variety of organic chemicals. The demand for crude oil is thus limited to those uses, in those times and places, where it is the least costly means of serving such needs.

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And by the early 1980s, proved technologies were already in place by which coal, natural gas or some other resource could substitute for oil in almost every one of its end-uses, and at costs not much higher (and in many cases far less) than the peak prices which crude oil then commanded in world markets.

The market value of every commodity is determined "at the margin." For oil, the effective margin consists of those uses and users for which substitutes come most cheaply. At the vicinity of prices that prevailed in mid-1987, liquid petroleum decisively abandons its industrial bulk-fuel markets to coal, gas and other primary energy sources. These markets are the uses in which the essential object of demand is calories at the least net cost, after taking into consideration the capital cost of fuel-burning equipment—electric-utility and industrial steam-generation, large-scale water- and space-heating, metallurgy, distillation, materials-drying and the like. At a few more dollars per barrel, oil would sacrifice the "front end" of the organic chemicals business to natural gas, gas liquids, and synthesis gas from coal and biomass. And at oil prices not much higher than the levels reached in the early 1980s, compressed and liquified gases, alcohols, and synthetic gasolines would quickly become viable substitutes for petroleum distillates in transport-fuel markets.

The potential for displacement for oil from these higher-value fuel uses may hardly be relevant to its price outlook over the foreseeable future, however. Global consumption of heavy fuel oils in bulk-fuel uses from which oil is vulnerable to substitution at around $20 still exceeds the current production of all the nations bordering the Persian Gulf. It is reasonable to infer, therefore, that the potential for fuel-substitution in the lowest-value uses of oil caps the price that even a permanently united and disciplined producer cartel could sustain. Over the years, moreover, this cap has a better chance of creeping downward than upward, if only because we can expect humanity's menu of usable energy resources to continue its relentless expansion, while the technical efficiency of their production, transportation, conversion, and end uses continues to improve.

Can Economics Prescribe a Price Floor?

Saudi Arabia and probably Iraq have crude-oil resources that could be produced at costs an order of magnitude or so less than current prices, and those resources are so big that they may reasonably be described with the same words that Einstein applied to the four-dimensional Universe—"finite but unbounded." The Saudis, at least if they simply tried to maximize their own oil revenues, would produce so much crude oil and consequently drive world prices so low, that they would impoverish the rest of OPEC, and with it much of the world's energy industry.

It is not difficult to find plausible explanations why the Saudi rulers have chosen to accept less than their potential market share in order to support a level of prices, much of whose financial benefit flows to political and religious enemies, and which, through its influence on the world's long-term fuel choices and fuel-using technology, damages the future value of the Kingdom's only export commodity. None of the motives commonly attributed to the Saudis however, flows directly from the facts of geology or from fundamental economic principles; even less is

their current strategy an inexorable consequence of human nature, Islamic theology, or the "Arab psyche."

Almost every existing or contemplated energy-supply investment outside the Middle East will always be at risk, therefore, from the volumes of crude oil with which the Saudis and perhaps others are capable of flooding the market at single-digit dollar prices, if even one of them was to adopt a radically different market strategy, or if the unity and discipline of OPEC totally vanished for some other reason. While the United States and some other industrialized countries might initially try to isolate their own energy producers from the consequences of such an event, others would surely decide to take competitive advantage of the availability of such low-cost fuels, and in doing so, make a policy of self-sufficiency at higher prices politically and economically untenable for any major power.

The pit may not really be bottomless, however. While the Saudi regime, acting alone as a rational revenue-maximizer, would tend to seek a price much lower than $18, it would not long want to hold prices down to $3 or even $7, notwithstanding its likely ability to do so. A price that decisively reversed the inroads of other fuels into the bulk-fuels market and checked the growth of non-OPEC crude-oil production would be low enough. Nobody, including the Saudis, really knows within a range of several dollars per barrel just what that price would be, but the $10-to-$12 range may be the best bet around.

Conclusion

The notion that world oil prices may be doomed to cycle widely, most of the time between the low teens and the low twenties in 1987 U.S. dollars, with the possibility of occasional short-lived excursions outside this range, is not an inherently pessimistic vision. The average constant-dollar crude-oil price implied by this forecast is higher than that which prevailed between 1875 and 1975, and prices are likely to be less volatile in the short run than was usually the case during the last hundred years, apart from three decades when the Texas Railroad Commission dominated the market. According to this outlook, oil prices would, indeed, be less unstable than the prices of most raw materials now traded on organized commodity markets.

Within this range of prices, petroleum liquids can remain the world's premier source of energy for some decades, because the global resource yet to be developed is enormous, because crude oil remains the cheapest energy form to move across or between continents in large volumes. At bottom, the future of petroleum is ensured by the same characteristics that place a ceiling on its price: Oil faces competition from other energy sources in all of its uses, precisely because it is the universal fuel, adaptable at reasonable cost to almost every one of mankind's energy needs.

Arlon R. Tussing

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Introduction

"The worldwide oil industry is still faced with massive excess crude production capacity. It is still uncertain when this overhanging surplus will be eliminated and alleviate the downward pressure on prices."

THE WORLDWIDE AND U.S. DOMESTIC OIL AND GAS INDUSTRY continues to be reshaped by new and changing economic and political events. And the changes are more volatile and are occuring more frequently. Profitable survival by those in the industry is dependent upon being aware of these changes and how they will shape the future.

After sliding slowly downward for over four years, the price of crude oil fell precipitously in 1986. The price fell to levels that most industry observers would have never expected to see again. But OPEC's adoption of a new production quota had prices moving back up again in late 1986 and into 1987. Political events throughout 1987 prevented the price from completely stabilizing. Where and when the price will settle are questions still unanswered.

The worldwide oil industry is still faced with massive excess crude production capacity. It is still uncertain when this overhanging surplus will be eliminated and alleviate the downward pressure on prices. The shift in control of the level of total worldwide crude oil production to OPEC has resulted in a much less predictable industry.

At the lower price levels, the volume of non-OPEC production has been adversely affected. Development of the higher cost non-OPEC areas has been curtailed or delayed. The impact on U.S. domestic exploration and production has been substantial. But the overall pace and level of the non-OPEC production adjustment to lower prices is still uncertain.

Exploration and development drilling in the U.S. hit a record low in the summer of 1986, following the drop in crude prices. But drilling costs have also come down and recent price increases have resulted in improved economics and a slight rebound in drilling. How long this upswing will be sustained is uncertain.

Product prices took a plunge along with crude oil prices. In response to the lower prices, demand for petroleum products moved upward more rapidly than anticipated. The extent of the surge in demand will undoubtedly depend upon the future level of prices. If demand continues to move up, it could go a long way toward significantly closing the surplus production gap. But the future demand level is uncertain.

The refining sector of the industry is also still faced with an excess capacity problem. Increasing demand could also go a long way toward resolving that problem. In 1986 refiners found profits in a new form of crude oil pricing — netback pricing. This enabled them to increase and maintain profits while the product prices were falling rapidly. But most of the netback pricing schemes have been eliminated and refining profits have suffered. If demand will continue to increase and netback pricing returns, is uncertain. This is only a partial list of events that are presently reshaping the industry and that will have a profound impact on the future of the industry.

Uncertainty is a reoccurring theme. Uncertainty is not new in the oil industry or elsewhere. Any philosopher will tell you, "The only thing certain in life is uncertainty." Anyone close to the oil industry will tell you that the

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"Forecasts are a valuable, essential tool for decision making. The 'bottom line' for the forecasting industry is a better decision."

only thing certain about the oil industry is uncertainty. That is uncertainty and risk. In today's oil industry environment the entire foundation for making projections, forecasts and decisions is unstable. About the only thing that is certain is that the future industry will not look like the past industry. And that means any new investment entails substantial risk.

Even in the face of all this uncertainty, forecasts have value. Forecasts are a valuable, essential tool for decision making. The 'bottom line' for the forecasting industry is a better decision. The more information obtained to assist operating and investment decisions, and the clearer the understanding of potential future events that will affect the industry, the more likely that a decision will make a positive contribution to a company's performance. A decision is seldom, if ever, 100% right or wrong. The outcome is usually some gradation of right or wrong. Any information that can improve the decision and increase the overall return on the company's investment is a valuable addition.

Forecasts and projections can be useful tools that help reduce risk. But in order to be a useful tool, a forecast must be based on an understanding of recent events and their affect on the industry. It must be internally logical and consistent, and it must use tried and tested economic theory as a framework. Any forecast must be founded on a set of assumptions. What is essential is that the basic assumptions used and conclusions drawn are logical, that they hold together based on an understanding of the industry, and that they reflect the actual workings of the industry and economic system.

The industry is changing, but the outcome is still determined by basic economic principles. Recent events may be shaping the future industry, but historical relationships should not be discarded without reliable proof of the change. Political, noneconomic events can upset the best forecast. But if a forecast is to be an aid in decision making, it must be based on known economic relationships rather than imagined future political events.

This outlook booklet has been developed to provide industry decision makers and analysts with a number of useful analytic tools. First it is an outlook for the worldwide and domestic oil and gas industry for the next five years. It is also a review of recent events that have had a major impact on the industry. And it is a guide to the factors to consider when preparing your own forecast for decision making; the factors that are essential and must be taken into consideration when making decisions based upon the future industry.

In addition, the booklet provides the essential oil and gas industry historical data for additional individual analysis. This enables the adoption of an alternative set of assumptions and the development of alternative outlooks. Although a decision must be based on one perception of the future, a set of alternative assumptions and forecasts often aids decision making. Alternative outlooks can provide the framework for accessing the penalties or rewards from being wrong about the future.

In order to operate profitably in the

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future, it is essential that companies develop a strategy for adapting to the changes occurring in the industry and a strategy for operating under the new conditions in the industry. The strategy that worked in the 1970's will not necessarily work in the 1980's, or in the 1990's.

This *Outlook* and future editions will be of assistance in clarifying recent events and trends, and providing a logical and consistent outlook.

The future may be filled with uncertainty, but it is also filled with exciting opportunities. The only way to take advantage of opportunities is to make decisions and take risks. This booklet will help reduce risks and make the decisions more profitable.

Worldwide Outlook
Demand

THE FIRST SEGMENT OF THIS FIVE-YEAR OUTLOOK will be a close look at the worldwide oil industry. To a substantial extent the oil industry is a global rather than regional industry, and the U.S. oil industry is very closely interrelated with the worldwide oil industry. Therefore, understanding what is presently occurring in and what the future holds for the U.S. oil industry is dependent upon understanding recent events, trends and expectations in the worldwide oil industry. Consideration must be given to the impact of worldwide economic and energy industry events on the future for the U.S. industry.

First there will be a look at trends in demand for petroleum products and the key factors that determine the level of petroleum product demand. This will be followed by a presentation of the outlook for worldwide demand for energy and petroleum products for the next five years, 1988-1992.

In general the level of worldwide economic activity is the key determinant of energy and oil product demand. Energy is an essential input for all types of economic activity. Therefore there is an extremely close relationship between economic activity and energy consumption. As long as there is economic activity energy will be consumed in some quantity and form. And in today's modern economic systems and high levels of economic activity vast quantities of energy are consumed in a wide variety of forms and sources.

Two of the basic energy sources, providing a substantial portion of total energy consumed, are oil and natural gas. These two energy sources provided 57.8% of total world energy in 1986. With the close relationship between economic activity and energy consumption, it becomes apparent that expectations for the future level of worldwide economic activity is also the key determinant of the future demand for oil and gas.

It should be pointed out that oil products and natural gas are consumed throughout the world in a wide variety of areas with differing levels and types of economic activity. Oil products are consumed throughout the world, in the industrial economies, the developing economies, and the centrally-planned economies of the communist countries. Demand for oil products and natural gas to fuel economic activity in all areas of the world is the determinant of the level of activity in the oil industry. Therefore, the energy needs and natural gas and petroleum product demand in all of these areas have been analyzed for this outlook.

"The price of energy in general and of the individual forms of energy, such as oil and natural gas, play a major role in determining the level of demand."

The price of energy in general and of the individual forms of energy, such as oil and natural gas, plays a major role in determining the level of demand. The relationship between economic activity and energy consumption was altered dramatically over the past ten to fifteen years because of the cost/price of energy. The rapid increase in the cost of oil, and energy in general, broke the lock-step relationship between economic growth and energy consumption. With much higher prices for energy and petroleum products, conservation became a dominant consideration when consuming energy and oil. This ever-changing relationship is also reviewed and forecast in the following sections. And

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price, one of the key determinant variables of the future level of activity, will also be reviewed and forecast.

"Over the period of 1972 to 1982, aggregate production was lower in 1986 than 1976."

REVIEW

ECONOMIC ACTIVITY. As mentioned, the level of worldwide economic activity is the key determinant of energy demand. There is no aggregate measure of overall world economic activity. The statistics required to measure overall eonomic activity in many of the developing areas are not collected or made available. Only rough estimates can be made of the level of activity.

But there are some regional measures, particularly for the industrial countries. Aggregate economic activity is measured for the countries in the Organization for Economic Cooperation and Development (OECD). This is a group of 24 industrial countries.

"Although there are differences in the rates of growth, the cyclical pattern over this period was strikingly similar. Because of the increase in worldwide trade, the economic fortunes of all of the countries in the OECD appear to be closely related."

Over the period of 1972 to 1982, aggregate real economic growth for the total group of countries averaged 2.5% per year. The most recent economic recession hit a trough in most of the industrial countries during the fourth quarter of 1982. Aggregate economic activity for the OECD was down 0.3% in 1982.

An upturn in economic activity started slowly in 1983. Real economic growth for the OECD group was 2.7% in 1983. The rate of growth accelerated in 1984, and the OECD total economic activity increased 4.7%. Economic growth slowed a bit in 1985 and 1986 with OECD aggregate activity up an estimated 3% and 2.5% respectively.

The growth in the U.S. economy led the way in 1983 and 1984 as real U.S. GNP increased 3.6% in 1983 and 6.4% in 1984. But U.S. economic growth slowed to 2.7% in 1985 and 2.5% in 1986. Japan followed with an increase in economic activity of 3.2% in 1983 and 5.1% in 1984. There growth slowed to 4.7% in 1985 and 2.5% in 1986.

Canada posted a rate of economic growth of 3.1% in 1983, 5.5% in 1984, 4% in 1985 and 3.1% in 1986. As a group the four major European industrial countries, Germany, France, United Kingdom and Italy had an economic growth rate of 1.6% in 1983, 2.6% in 1984, 2.4% in 1985 and 2.4% in 1986.

Although there are differences in the rates of growth, the cyclical pattern over this period was strikingly similar. Because of the increase in worldwide trade, the economic fortunes of all of the countries in the OECD appear to be closely related.

The 1987 estimated rate of economic growth for the OECD group is slightly lower than the previous year at 2.25%. None of the major countries are expected to have a growth rate over 3% in 1987.

Industrial production, which increased only 1.25% in the OECD countries in 1986, is estimated to be up 2.25% in 1987. And it is projected to increase 3.0% during the first half of 1988. Industrial activity tends to be more energy intensive than many other aspects of economic activity and therefore growth in this sector stimulates energy demand.

Worldwide aggregate economic activity growth slowed to an estimated 3% in 1985 according to a United Nations

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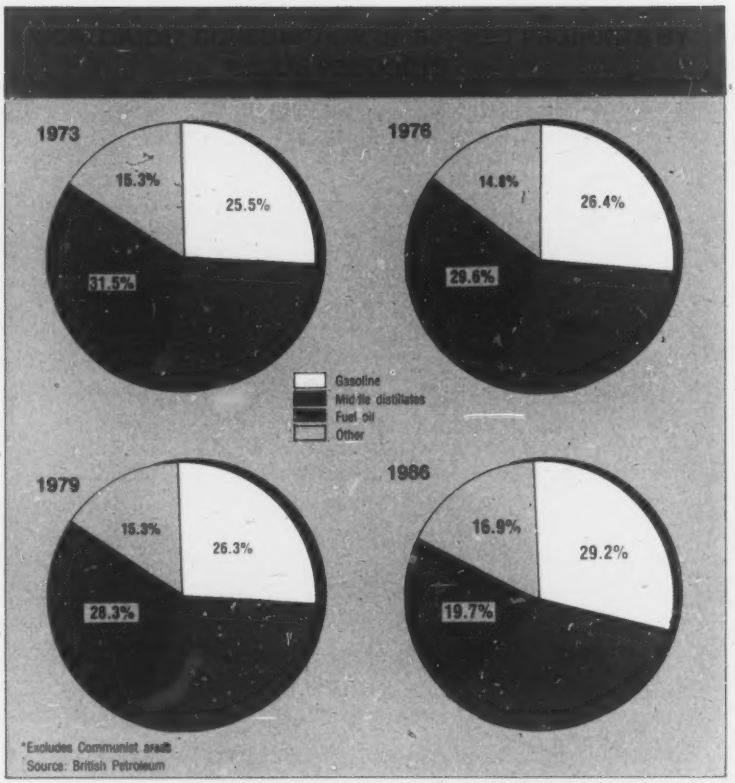
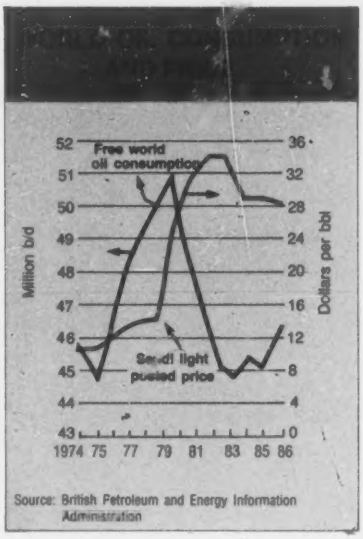


Worldwide Demand



WORLDWIDE PETROLEUM PRODUCT MARKET SHARE

	1973 (%)	1976 (%)	1979 (%)	1982 (%)	1985 (%)	1986 (%)
U.S. and CANADA						
Gasoline	37.6	38.5	37.3	41.5	42.0	41.9
Middle distillates	25.2	25.7	27.0	26.9	28.6	28.5
Fuel oil	18.4	18.0	17.1	12.9	9.2	10.1
Other	18.8	17.8	18.6	18.7	20.2	19.5
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
WESTERN EUROPE and JAPAN						
Gasoline	17.2	18.5	19.4	21.4	23.0	23.4
Middle distillates	29.4	30.8	32.0	33.9	37.4	38.1
Fuel oil	40.5	38.4	35.4	29.8	23.5	22.4
Other	12.9	12.3	13.2	14.9	16.1	16.1
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
REST OF WORLD*						
Gasoline	19.1	18.6	18.9	19.1	19.9	19.8
Middle distillates	29.0	32.7	32.1	33.9	36.7	36.8
Fuel oil	37.8	34.6	35.3	33.1	29.2	29.2
Other	14.1	14.1	13.7	13.9	14.2	14.2
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
TOTAL WORLD*						
Gasoline	25.5	26.4	26.3	28.0	29.1	29.2
Middle distillates	27.7	29.2	30.1	31.4	34.0	34.2
Fuel oil	31.5	29.6	28.3	24.6	19.8	19.7
Other	15.3	14.8	15.3	16.0	17.1	16.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

*Excludes communist areas

Source: British Petroleum

report. The growth rate for world output was estimated at around 3.5% for 1986 and 1987 according to the U.N. Developing countries are expected to experience some increase in their rate of growth. For the developing countries the rate of growth was 2.4% in 1985 and it is estimated at 3% in 1986 and 3.5% in 1987.

Although lower energy prices helped the oil importing developing countries, they had a negative impact on the oil exporting countries. Energy-exporting developing countries have, until recently, accounted for around 40% of the combined economics activity of the developing countries.

"World primary energy consumption moved up steadily through the 1950's, 1960's and 1970's to 50.97 billion barrels of oil equivelant in 1979."

Offsetting lower energy prices is the depressing impact of huge budget deficits, huge worldwide debt and growing protectionism. All of these factors tend to slow economic growth. However, if these factors can be brought under control without stimulating another round of worldwide inflation, prospects for continued worldwide economic growth are rather good. A major key to economic growth is the level of investment and this can be stimulated if inflation is kept under control and the dept burden is managed properly and slowly reduced. Expectations for this outlook are that these problems will not be eliminated but will be controlled and the world economy will continue to expand.

ENERGY. As stated, the relationship between economic growth and energy has changed markedly. Price-induced conservation has reduced energy consumption throughout the industrial world. This has been more pronounced in recent years, following the 1978-79 oil price hike. In developing areas, conservation of energy has not been as evident as in industrial areas. In these developing areas, industrialization is still the major economic policy objective and supersedes attempts at conservation.

The ratio of energy to gross economic output can be expected to continue to fall worldwide, particularly in the industrial areas. However, the lower energy prices should slow conservation efforts and the change in this ratio. This will be particularly true in those areas where lower energy costs are passed through to the consumer.

World primary energy consumption has been on the rise again in recent years. Total world primary energy consumption moved up 2.1% in 1986 to a peak of 55.6 billion barrels of oil equivalent.

World primary energy consumption moved up steadily through the 1950's, 1960's and 1970's to 50.97 billion barrels of oil equivalent in 1979.

During the ten-year span, 1969-1979, world energy consumption increased 51.6%, or at an average annual rate of about 4.2% per year. However, following the sharp increase in energy costs in the 1970's and early 1980's, a conservation effect was felt and energy consumption leveled off and fell. Energy consumption fell 1.0% between 1979 and 1981 to a recent low of 50.4 billion barrels of oil equivelant.

As energy prices began to slide, consumption increased, moving up marginally in 1982 and up 1.4% in 1983. Still lower energy prices and more vigorous economic growth helped boost energy consumption another 3.7% in

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WORLDWIDE PRIMARY ENERGY CONSUMPTION AND MARKET SHARE

	1974	% of total	1976	% of total	1979	% of total	1980	% of total	1982	% of total	1984	% of total	1985	% of total	1986	% of total
	(Million barrels oil equivalent)															
Oil	20,234	46.4	21,217	46.0	22,907	45.0	21,980	43.4	20,461	40.6	20,693	39.1	20,594	37.8	21,118	38.0
Natural gas	7,976	18.3	8,398	18.2	9,405	18.5	9,588	18.9	9,746	19.4	10,585	2.0	10,952	20.1	11,047	19.9
Coal	12,396	28.4	13,086	28.4	14,431	28.3	14,677	29.0	14,998	29.8	15,946	30.1	16,659	30.6	16,926	30.4
Water power	2,519	5.8	2,627	5.7	3,058	6.0	3,134	6.2	3,361	6.7	3,614	6.8	3,744	6.9	3,807	6.8
Nuclear	457	1.1	770	1.7	1,121	2.2	1,240	2.5	1,794	3.5	2,137	4.0	2,552	4.6	2,732	4.9
Total*	**43,582**	**100.0**	**46,098**	**100.0**	**50,922**	**100.0**	**50,619**	**100.0**	**50,360**	**100.0**	**52,975**	**100.0**	**54,501**	**100.0**	**55,630**	**100.0**

*Excludes miscellaneous fuels not mentioned specifically.

Source: British Petroleum

WORLDWIDE OIL CONSUMPTION

Country Area	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	% change 86/73	% change 86/79
	(1,000 b d)																				
NORTH AMERICA																					
U.S.*	13,085	13,815	14,350	14,845	15,990	16,870	16,150	15,875	16,980	17,925	18,255	17,910	16,460	15,550	14,765	14,745	15,175	15,170	15,560	−7.8	−13.1
Canada	1,375	1,440	1,525	1,585	1,655	1,755	1,785	1,735	1,790	1,810	1,835	1,915	1,855	1,760	1,565	1,475	1,425	1,490	1,455	−17.1	−24.0
Total North America	**14,460**	**15,255**	**15,875**	**16,430**	**17,645**	**18,625**	**17,935**	**17,610**	**18,770**	**19,735**	**20,090**	**19,825**	**18,315**	**17,310**	**16,330**	**16,220**	**16,600**	**16,660**	**17,015**	**−8.6**	**−14.2**
WESTERN EUROPE																					
Austria	150	160	185	205	215	235	210	215	230	225	240	250	245	225	210	205	200	200	210	−10.6	−16.0
Belgium & Luxembourg	440	500	560	570	620	635	560	535	560	565	585	560	540	500	475	435	420	430	480	−24.4	−14.3
Denmark	275	330	365	365	385	360	320	315	335	330	325	320	275	260	225	215	210	220	215	−40.3	−32.8
Finland	165	190	210	220	235	260	230	235	255	250	250	265	255	245	230	215	215	220	230	−11.5	−13.2
France	1,470	1,705	1,920	2,090	2,315	2,585	2,460	2,255	2,430	2,350	2,445	2,435	2,260	2,060	1,915	1,880	1,815	1,790	1,820	−29.6	−25.3
Greece	115	125	135	150	170	200	185	195	210	215	230	250	250	240	240	230	235	245	250	25.0	—
Iceland	10	10	10	10	10	15	15	10	10	10	10	15	10	10	10	10	10	10	10	−33.3	−3.3
Republic of Ireland	70	75	80	90	100	110	110	105	105	115	125	130	120	105	95	85	85	85	90	−18.2	−30.8
Italy	1,385	1,530	1,740	1,875	1,965	2,070	2,015	1,895	2,065	1,920	2,015	2,080	1,970	1,940	1,845	1,820	1,735	1,730	1,775	−14.3	−14.7
Netherlands	590	650	725	720	805	835	725	710	795	770	795	855	800	745	655	625	625	635	690	−17.4	−19.3
Norway	135	150	165	165	170	175	160	165	180	180	195	200	200	190	180	180	190	200	205	17.1	2.5
Portugal	70	80	95	115	120	130	135	140	145	150	150	165	170	180	195	195	195	180	200	53.8	21.2
Spain	435	495	565	635	655	790	820	865	970	930	955	1,015	1,070	1,040	990	1,010	955	925	930	17.7	−8.4
Sweden	470	530	590	560	565	585	540	535	590	560	535	545	500	455	420	375	360	375	370	−36.8	−32.1
Switzerland	210	230	260	275	280	300	270	260	270	270	280	270	270	250	235	260	250	255	280	−6.7	3.7
Turkey	130	140	155	180	200	250	255	275	310	340	315	300	300	315	335	330	370	345	390	56.0	30.0
United Kingdom	1,840	1,980	2,095	2,105	2,230	2,300	2,135	1,875	1,860	1,885	1,930	1,945	1,670	1,560	1,580	1,530	1,850	1630	1,640	−28.7	−15.7
West Germany	2,135	2,420	2,655	2,745	2,885	3,070	2,760	2,655	2,855	2,855	2,960	3,050	2,725	2,465	2,355	2,340	2,330	2,391	2,525	−17.8	−17.2
Total Western Europe	**10,095**	**11,300**	**12,510**	**13,075**	**13,925**	**14,905**	**13,905**	**13,240**	**14,175**	**13,920**	**14,340**	**14,650**	**13,630**	**12,785**	**12,190**	**11,940**	**12,050**	**11,865**	**12,310**	**−17.4**	**−16.0**
AUSTRALASIA																					
Australia	455	485	510	535	540	590	610	605	630	655	655	665	630	625	610	590	610	590	600	−1.7	−9.8
New Zealand	70	70	85	85	90	95	95	90	95	95	95	90	90	85	85	80	85	80	85	−10.5	−5.6
Total Australasia†	**525**	**555**	**595**	**620**	**630**	**685**	**705**	**695**	**725**	**750**	**750**	**755**	**720**	**710**	**695**	**670**	**695**	**670**	**685**	**—**	**−9.3**
Japan	2,850	3,390	4,000	4,435	4,735	5,460	5,270	5,020	5,190	5,350	5,420	5,485	4,935	4,695	4,395	4,390	4,565	4,380	4,415	−19.1	−19.5
Total OECD	**27,930**	**30,500**	**32,980**	**34,560**	**36,935**	**39,675**	**37,815**	**36,565**	**38,860**	**39,755**	**40,600**	**40,715**	**37,600**	**35,500**	**33,610**	**33,220**	**33,910**	**33,575**	**34,425**	**−13.2**	**−15.4**
Cyprus Gibraltar Malta	20	20	20	25	25	25	25	20	25	25	25	30	30	30	30	30	35	35	40	60.0	33.3
Latin America	2,325	2,510	2,645	2,820	3,060	3,355	3,495	3,520	3,570	3,820	3,975	4,230	4,400	4,435	4,540	4,450	4,420	4,425	4,535	35.2	7.2
Middle East	795	920	965	1,055	1,115	1,210	1,320	1,320	1,475	1,565	1,620	1,495	1,625	1,780	2,050	2,285	2,155	2,150	2,150	77.7	43.8
Africa	735	795	855	900	920	1,010	1,035	1,050	1,155	1,205	1,290	1,360	1,450	1,525	1,610	1,630	1,630	1,700	1,690	67.3	24.3
Southeast Asia	455	535	540	565	585	635	600	610	665	705	760	775	825	890	935	950	1,030	1,105	1,165	83.5	50.3
South Asia	830	905	1,030	1,135	1,285	1,465	1,510	1,535	1,675	1,805	2,015	2,280	2,325	2,375	2,300	2,310	2,315	2,280	2,435	66.2	6.8
Total Non-Communist World	**33,090**	**36,185**	**39,035**	**41,060**	**43,925**	**47,375**	**45,800**	**44,620**	**47,425**	**48,880**	**50,285**	**50,885**	**48,255**	**46,535**	**45,075**	**44,875**	**45,495**	**45,270**	**46,440**	**−2.0**	**−8.7**
COMMUNIST																					
China	300	400	560	725	855	1,065	1,225	1,350	1,630	1,630	1,705	1,835	1,765	1,705	1,660	1,705	1,750	1,785	1,990	86.9	8.4
U.S.S.R.	4,515	4,815	5,310	5,655	6,115	6,595	7,280	7,520	7,780	8,125	8,480	8,640	8,795	8,985	9,115	9,035	8,895	8,910	9,005	36.5	4.2
Others	1,200	1,400	1,535	1,715	1,870	2,010	2,090	2,235	2,438	2,595	2,675	2,755	2,730	2,625	2,575	2,490	2,490	2,530	2,485	23.6	−9.8
Total Communist	**6,015**	**6,615**	**7,405**	**8,095**	**8,840**	**9,670**	**10,595**	**11,105**	**11,740**	**12,350**	**12,860**	**13,230**	**13,290**	**13,315**	**13,350**	**13,230**	**13,135**	**13,225**	**13,480**	**39.4**	**1.9**
Total World	**39,105**	**42,800**	**46,440**	**49,155**	**52,765**	**57,045**	**56,395**	**55,725**	**59,165**	**61,230**	**63,145**	**64,115**	**61,545**	**59,850**	**58,425**	**58,105**	**58,630**	**58,495**	**59,920**	**5.0**	**−6.5**

*U.S. processing gain has been deducted from local domestic product demand. †Includes Australia and New Zealand.

Source: British Petroleum

1984. It again moved up in 1985, 2.6%, to 54.5 billion barrels.

Most of the energy conservation took place in the non-communist countries. During the period 1979 through 1982, energy consumption fell 3.7%, from 34.7 billion barrels oil equivalent to 33.5 billion barrels in the non-communist countries. Over the same three-year span, energy consumption in the communist countries moved up 4.9%. With their extensive network of controls, world prices had a lot less impact on energy consumption in those countries.

"With the upswing in overall economic activity, energy consumption can be expected to increase over the forecast period."

Energy consumption in the non-communist countries began to move up again as prices moderated, increasing 0.6% in 1983, 4.0% in 1984 and 2.8% in 1986. This is an increase of 7.8% over the four-year span.

The conservation effect had the biggest impact on the industrial countries with energy-intensive economies. Between 1979 and 1983, U.S. energy consumption fell 10.2%. Western Europe's energy consumption fell 8.1% and Japanese' energy consumption fell 7.8%. Most of these countries were highly dependent upon oil to fuel economic growth, and the huge increase in oil prices provided substantial incentive for conservation.

Even with moderately lower energy prices, growth in energy consumption has been modest in these industrial areas over the 1982 through 1986 period. U.S. energy consumption in 1986 was down 0.1% from 1985 but up 4.8% from the recent low in 1983. Western Europe's energy consumption was up 1.8% in 1986 from 1985, and up 6.7% from 1983. Japanese' energy consumption was up 0.2% in 1986 from 1985, and up 9.1% from 1982.

With the upswing in overall economic activity, energy consumption can be expected to increase over the forecast period.

Conservation will continue to dampen demand, but this should be offset by the effect of lower prices and economic growth. The lower energy prices which the world is now experiencing should severely diminsh the conservation effort and boost energy consumption.

There has been a substantial shift in the market share of the various forms of primary energy. Over the period 1972 through 1983, oil's share of total worldwide primary energy fell from 46% to 40.3%. It then dropped to 39.1% in 1984, and 37.8% in 1985. Lower oil prices helped boost it back up to 38% in 1986.

Although there have been year-to-year fluctuations in relative market shares, all other primary fuels gained market share at the expense of oil over the period 1972-1985. The sharp drop in oil prices in 1986 changed this trend slightly.

Natural gas moved up from 18.6% in 1972 to 20.0% in 1984, and 20.1% in 1985. But the natural gas share slipped to 19.9% in 1986. Coal increased from 28.9% in 1972 to 30.1% in 1984 and 30.6% in 1985. Coal slipped to 30.4% in 1986. Nuclear power supplied only 0.7% of total energy in 1972, but moved up to 4.0% in 1984, 4.6% in 1985 and 4.9% in 1986. Hydroelectric power contributed 5.8% in 1972, 6.8% in 1984, 6.9% in 1985 and it slipped to 6.8% in 1986.

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WORLDWIDE PRIMARY ENERGY CONSUMPTION

Country/Area	1973	1976	1979	1982	1985	1986	% change 86/73	% change 86/79
	(Million barrels oil equivalent)							
NORTH AMERICA								
U.S.	13,288.6	13,216.7	14,031.1	12,665.5	13,216.0	13,199.9	-0.7	-5.9
Canada	1,399.3	1,515.1	1,625.8	1,575.2	1,633.1	1,690.3	20.8	4.0
Total North America	**14,687.9**	**14,731.8**	**15,656.9**	**14,240.7**	**14,849.1**	**14,890.2**	**1.4**	**-4.9**
WESTERN EUROPE								
Austria	174.5	173.7	193.5	178.9	184.7	188.4	8.0	-2.6
Belgium & Luxembourg	372.4	365.0	374.6	337.2	352.6	362.1	-2.8	-3.3
Denmark	144.4	140.7	147.3	122.4	134.9	137.8	-4.6	-6.4
Finland	131.2	134.9	158.3	156.9	165.7	167.9	28.0	6.1
France	1,364.1	1,342.9	1,414.0	1,332.6	1,382.4	1,414.0	3.7	—
Greece	112.1	137.1	127.5	123.1	139.3	141.5	26.2	11.0
Iceland	15.4	15.4	13.9	11.0	11.0	11.7	-24.0	-15.8
Republic of Ireland	54.2	52.8	65.2	60.8	62.3	62.3	14.9	-4.4
Italy	1,010.8	1,046.0	1,097.3	1,029.9	1,023.3	1,037.2	2.6	-5.5
Netherlands	563.7	559.3	575.4	496.2	510.9	527.8	-6.4	-8.3
Norway	206.0	225.0	232.4	237.5	234.6	231.6	12.4	-0.3
Portugal	66.0	64.5	82.8	90.9	78.4	84.3	27.7	1.8
Spain	423.7	494.0	552.7	564.9	571.0	584.9	38.0	5.8
Sweden	337.9	359.9	365.8	338.6	392.2	388.5	15.0	6.2
Switzerland	175.2	165.7	179.6	188.4	209.6	211.1	20.5	17.5
Turkey	131.9	166.4	171.5	203.0	228.0	245.6	86.2	43.2
United Kingdom	1,647.8	1,520.2	1,626.5	1,421.3	1,481.4	1,519.5	-7.8	-6.6
West Germany	1,941.7	1,902.9	2,103.7	1,829.6	1,962.2	1,973.2	1.6	-6.2
Total Western Europe	**8,873.0**	**8,866.4**	**9,482.0**	**8,713.2**	**9,124.5**	**9,289.4**	**4.7**	**-2.0**
AUSTRALASIA*								
Australia	397.3	458.9	527.8	549.0	578.3	623.8	57.0	18.2
New Zealand	76.2	81.4	82.1	84.3	97.5	107.8	41.5	31.3
Total Australasia*	**473.5**	**540.3**	**609.9**	**633.3**	**675.8**	**731.6**	**54.5**	**20.0**
Japan	2,548.6	2,526.7	2,711.4	2,499.5	2,722.4	2,726.8	7.0	0.6
Total OECD	**26,583.0**	**26,665.2**	**28,460.2**	**26,086.7**	**27,371.8**	**27,638.0**	**4.0**	**-2.9**
Cyprus Gibraltar Malta	10.3	9.5	11.0	11.7	14.7	15.4	49.5	40.0
Latin America	1,726.9	1,930.7	2,353.7	2,627.1	2,820.6	2,876.3	66.6	22.2
Middle East	639.2	757.2	796.8	1,032.1	1,166.9	1,180.9	84.7	48.2
Africa	719.1	862.0	1,106.1	1,337.0	1,400.8	1,418.4	97.2	28.2
South Asia	757.2	839.3	929.4	1,181.6	1,445.5	1,513.6	99.9	62.9
Southeast Asia	693.4	785.8	1,082.6	1,174.3	1,345.8	1,424.2	105.4	31.6
Total Non-Communist World	**31,129.1**	**31,849.7**	**34,739.8**	**33,450.5**	**35,566.1**	**36,066.8**	**15.9**	**3.8**
COMMUNIST								
China	2,657.1	3,206.1	3,931.8	3,834.3	4,658.9	4,916.2	85.0	25.0
U.S.S.R.	6,407.2	7,452.4	8,312.2	9,145.6	10,019.4	10,366.1	61.8	24.7
Others	3,161.4	3,642.3	3,989.0	4,056.4	4,256.5	4,280.7	35.4	7.3
Total Communist	**12,225.7**	**14,300.8**	**16,233.0**	**17,036.3**	**18,934.8**	**19,563.0**	**60.0**	**20.5**
Total World	**43,354.8**	**46,150.5**	**50,972.8**	**50,486.8**	**54,500.9**	**55,629.8**	**28.3**	**9.1**

*Includes Australia and New Zealand
Source: British Petroleum

WORLDWIDE PETROLEUM PRODUCT CONSUMPTION

	1973	1976	1979	1982	1985	1986	% change 79/73	% change 86/79	% change 86/73
	(Million barrels)								
U.S. and Canada	6,609.5	6,657.8	7,022.9	5,705.7	5,810.5	5,965.9	6.3	-15.1	-9.7
Gasoline	2,487.8	2,565.5	2,619.0	2,366.1	2,441.6	2,501.7	5.3	-4.5	0.6
Middle distillates	1,663.2	1,712.3	1,893.3	1,537.1	1,663.9	1,697.6	13.8	-10.3	2.1
Fuel oil	1,214.6	1,201.4	1,198.5	737.4	534.4	600.3	-1.3	-49.9	-50.6
Other	1,243.9	1,178.6	1,312.1	1,065.1	1,170.6	1,166.3	5.5	-11.1	-6.2
Western Europe and Japan	7,461.9	6,954.0	7,181.9	5,832.5	5,629.4	5,787.0	-3.8	-19.4	-22.4
Gasoline	1,285.7	1,285.7	1,396.4	1,250.5	1,293.0	1,356.1	8.6	-2.9	5.5
Middle distillates	2,196.1	2,144.0	2,300.2	1,976.9	2,107.4	2,204.9	4.7	-4.1	0.4
Fuel oil	3,023.6	2,668.1	2,545.0	1,738.7	1,321.6	1,297.4	-15.8	-49.0	-57.1
Other	956.5	856.2	940.3	866.4	907.4	928.6	-1.7	-1.2	-2.9
Rest of World*	3,008.2	3,346.1	3,912.0	4,335.7	4,370.1	4,488.2	30.0	14.7	49.2
Gasoline	574.7	622.3	739.6	829.0	868.6	888.4	28.7	20.1	54.6
Middle distillates	872.3	1,093.6	1,257.1	1,468.2	1,603.8	1,650.0	44.1	31.3	89.2
Fuel oil	1,136.9	1,158.1	1,381.0	1,434.5	1,277.6	1,309.1	21.5	-5.2	15.2
Other	424.3	472.1	534.3	604.0	620.1	640.7	25.9	19.9	51.0
Total World*	17,079.6	16,958.0	18,116.8	15,873.8	15,810.1	16,241.1	6.1	-10.4	-4.9
Gasoline	4,348.2	4,473.5	4,755.0	4,445.6	4,603.2	4,746.2	9.4	0.2	9.2
Middle distillates	4,731.6	4,949.9	5,450.6	4,982.2	5,375.1	5,552.5	15.2	1.9	17.3
Fuel oil	5,375.1	5,027.6	5,124.4	3,910.6	3,133.6	3,206.9	-4.7	-37.4	-40.3
Other	2,624.7	2,507.0	2,786.8	2,535.4	2,698.2	2,735.5	6.2	-1.8	4.2

*Excludes communist areas Source: British Petroleum

The rapid rise in the price of oil relative to other fuels led to fuel switching. This was particularly true for heavy industry and electric utilities. With the high price, oil became the "swing fuel," supplying energy when other fuels were not available. Total world energy consumption is up 34.8% over the 1972-1986 period, while energy from oil is up only 11.7%.

"During the next few years, oil's share of the total market will drop only marginally."

The rapid rise in oil prices made the consumers, worldwide, oil energy cost-conscious. Where possible, fuel switching to less costly fuels took place. In general, energy costs had risen enough to become a major concern in the economics of industrial production and in the cost of living, and substantial price-induced conservation took place.

During the next few years, oil's share of the total market will drop only marginally. The drop in crude prices has made oil more competitive with other fuel sources and also has slowed investment in conservation. Oil's share of the market may even increase and replace coal or natural gas in certain areas.

"Oil's share of the market may even increase and replace coal or natural gas in certain areas."

OIL PRODUCT DEMAND. Non-communist worldwide demand for oil products followed two distinct trends between 1972 and 1983. From 1972 through 1979, free-world demand was on the rise, increasing 15.8% over this seven-year span. From 1979 through 1983, demand for oil fell as price-induced conservation took over. Consumption dropped 11.8% over this four-year time period. The net effect was that free-world demand in 1983 was only 2.2% above 1972.

There was a reversal of this downward trend in 1984 as lower prices and economic activity boosted demand 1.4%, demand fell 0.5% in 1985, but moved up 2.6% in 1986.

This could be the start of a new upward trend in oil demand. Lower oil prices, particularly real oil prices adjusted for inflation, are expected to couple with increased economic activity to boost demand throughout the forecast period.

In addition to the price-induced conservation reducing demand through increased oil energy efficiency, fuel switching has had an impact. It has helped to reduce overall demand for petroleum products, and also changed the proportion of petroleum products consumed.

The impact of competitive fuels, coal, nuclear and water power is most evident in the consumption of heavy fuel oil. Consumption of heavy fuel oil in the non-communist world was 5.1 billion barrels in 1979. Demand fell 38.8% to 3.1 billion barrels in 1985. Sharply lower prices for heavy fuel oil boosted demand 2.6% last year.

In the U.S. heavy fuel oil consumption fell 58.1% from 1977 to 1985. But demand rebounded in 1986 moving up 13.3%. Demand in Western Europe fell 50.5% between 1976 and 1985. But consumption remained at the 1985 level in 1986. However consumption in Japan did continue to slide in 1986 but at a slower rate. Demand fell 5.3% in 1986 to 433 million barrels. Lower fuel oil prices made fuel oil more competitive with other forms of energy. This may actually increase the demand for fuel oil during the forecast period.

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Gasoline consumption in the non-communist world peaked in 1978 at 4.8 billion barrels. With higher prices demand fell rapidly, 6.9% to 4.4 billion barrels in 1982. But as prices slipped demand moved back up steadily from 1982 through 1986. Demand in 1986 was 4.7 billion barrels up 6.8% from 1982. Demand in 1986 was 3.1% above 1985.

Demand in the U.S. also peaked in 1978 and then fell rapidly, 13% by 1982. Consumption in 1986 was up 2.8% from 1985 and up 6.7% from the recent low in 1982.

The pattern in Europe was similar. Gasoline consumption peaked in 1979, and then dropped abruptly, 9.1% by 1981. Demand has moved back up steadily since 1981. It jumped up 5.1% in 1986 from 1985, and was 8.8% above 1981.

In the developing countries demand has continued to climb steadily throughout the 1970's with only a slight slip in 1983 and 1984 due to the high prices. In these other areas demand was at a record high 788 million barrels in 1986.

Middle distillate demand also rebounded in 1986, moving up 3.3% for the non-communist world to a new high of 5.6 billion barrels. The previous peak year was 1979. Middle distillate demand slid 8.6% between 1979 and 1982. But with increased economic activity, middle distillate demand has been increasing over the four years since 1982.

Consumption of all other petroleum products moved up 1.4% in 1986 to 2.7 billion barrels. Demand in 1986 was down only 1.8% from the peak in 1979.

"From a geographical perspective, the shift is most pronounced in the United States, Western Europe and Japan. In these areas there has been a major shift away from fuel oil and an increase in demand for gasoline and middle distillates."

As can be seen from this, there has been a major shift in petroleum product demand to a larger percentage of lighter products. As pointed out, the major reason has been the reduction in demand for fuel oil. But in addition, demand for middle distillates, motor gasoline and other products has held up fairly well.

Demand for petroleum products in the non-communist world peaked in 1979 at 18.1 billion barrels. This fell 13.1% to 15.8 billion barrels in 1985. The drop in fuel oil consumption accounted for 86.3% of the decline. Total demand in 1986 was down 1,876 million barrels from the peak. Fuel oil demand in 1986 was down 1,918 million barrels, in effect accounting for more than the total drop.

From a geographical perspective, the shift is most pronounced in the United States, Western Europe and Japan. In these areas there has been a major shift away from fuel oil and an increase in demand for gasoline and middle distillates. In the rest of the free world, the shift has not been as pronounced, but is also in evidence.

Over the ten-year period 1975 through 1986, the product demand mix changed markedly. In the U.S., the fuel oil share of the total barrel dropped from 16.9% in 1975 and 18.6% in 1977 to 9.2% in 1985. Gasoline moved up from 39.8% in 1975 to 42.1% in 1985. And middle distillates increased from 24.8% to 28.1%. There was a slight reversal of trend in 1986 when low prices pushed up heavy fuel demand. Fuel oil moved up to 10.2% and gasoline slipped to 42%. Middle distillates remained at 28.1%.

In Canada, the fuel oil share moved from 19.4% down to 8.3% in 1986. Gasoline consumption increased from 34.9% in 1975 to 40.7% in 1986. And middle distillates increased from 31.4% to 32.3%.

In Western Europe and Japan the drop in fuel oil demand was even more pronounced. In Europe, fuel oil demand dropped from 34.5% of the market in 1975 to 20.1% in 1986. Gasoline in Europe moved up from 19.1% to 24.4%. And middle distillates shifted from 33.7% to 40.1%. In Japan, fuel oil fell from 51.3% of oil product consumption in 1975 to 28.9% in 1986. Gasoline moved from 16.1% to 20.8%, and middle distillates from 20.7% to 32.3%.

"Looking at product consumption from the geographical perspective, what stands out most is the difference in trends between the industrial countries and the other, less- developed, countries."

There are obvious geographical differences, with gasoline being a much greater share of the North American market, with fuel oil relatively more important but diminishing in importance elsewhere.

Looking at product consumption from the geographical perspective, what stands out most is the difference in trends between the industrial countries and the other, less-developed, countries.

Total consumption in the U.S., Canada, Western Europe, and Japan, was down 13.7% in 1986 from 1976. For the remainder of the non-communist world, consumption in 1986 was up 34.1% from 1976.

PRICES. As was mentioned in the introduction, there was an abrupt alteration of the relationship between economic activity and energy consumption. This alteration was primarily due to the rapid increase in the cost of oil and other energy in the 1970's.

Oil, and other energy costs, increased more rapidly than other economic costs. This made energy a more important consideration in business decision making. The result was an adjustment in investment decisions with more concern for cost-cutting energy-saving investments.

This shift altered the emphasis of investment decisions; from investing for increased economic output for consumption, to an emphasis on energy cost cutting. This contributed to a drop in energy demand, but also slowed worldwide economic growth.

From 1972 to 1982, the posted price of Saudi Arabian marker crude increased from $2.48/bbl to $34/bbl, an increase of 1,271% or $31.22/bbl. The real price adjusted for inflation increased 546%. This far surpassed the average price increase for all commodities of 151% over this period.

The sharp increase in prices did not initially slow demand for petroleum products. There is some evidence that the price of crude oil was below the market equilibrium price in the 1960's, and this encouraged demand. Therefore, the initial 1973-74 increase was easily absorbed. Another reason that demand did not appear to react to the initial price increase was that many energy and oil conservation investments take time to exert a measurable impact. In the industrial, utility and residential-/commercial sectors, it may take up to 10 years or more before the majority of the impact from conservation investment is felt.

Adjustment to prices can be very

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rapid in the transportation sector of the economy. Much of the conservation is in the form of a change in discretionary driving habits. But there are also fewer substitutes for petroleum products in this sector, and this offsets some of the potential impact from higher prices.

"The drop in oil demand as a response to prices, and the worldwide economic slow-down, put downward pressure on crude prices."

Current dollar prices levelled off after the initial price shock of 1973-74, and the real inflation-adjusted price fell. This muted the conservation adjustment to this price hike.

However, the 1979-80 price boost produced a much more dramatic adjustment. That price jump coupled with forecasts of future rapidly-rising oil prices led to a sharp drop in oil use.

Between 1978 and 1981, the world price of oil jumped another 152%. Responding to this rapid increase in prices, the demand for oil in the non-communist world peaked in 1979 and dropped 13.8% by 1983. Over this four-year period, the worldwide demand response to the price increase was a 0.9% drop in demand for every 10% increase in price. This is relatively inelastic demand. But it does show that there is a demand response to price that must be considered when estimating demand for oil products.

"It should be noted that the strong U.S. dollar at that time relative to other currencies resulted in oil prices being higher outside the U.S."

The drop in oil demand as a response to prices, and the worldwide economic slow-down, put downward pressure on crude prices. A massive crude production capacity surplus developed when demand fell. The result was a peaking of crude prices in March 1981. Although the official price of the OPEC marker Saudi light crude was boosted to $34/bbl in 1982, actual average transaction prices were falling.

The Saudi light crude marker price was lowered to $29 in early 1983, and again to $28 at the beginning of 1985. This was a 17.6% drop in the official marker crude price. The drop in actual transaction prices was even greater as more and more crude oil trading was based on spot market prices.

The lower crude oil prices had a small positive impact on demand in the non-communist countries. Demand moved up 2.0% in 1984, but slipped 1.1% in 1985.

It should be noted that the strong U.S. dollar at that time relative to other currencies resulted in oil prices being higher outside the U.S. Export crudes, particularly from OPEC, are denominated in U.S. dollars. In several European countries, oil prices, and therefore petroleum product prices, had actually risen from 1981 to 1985. That has tended to suppress demand for petroleum products in Europe and other areas in recent years.

Prices were prevented from falling even more rapidly in the 1981-1985 period by the willingness of Saudi Arabia to support prices through a reduction in their production level.

But the most significant recent pricing events occurred in late 1985. First Saudi Arabia became alarmed when their production fell below 2 million b/d, in the swing producer role. They were not getting cooperation from other OPEC countries in cutting production to support prices.

So Saudi Arabia abandoned their role of crude exporter of last resort in the fall of 1985 and decided on concentrating on a "fair share" of the market.

They adopted a netback pricing

scheme that enabled them to recapture a substantial share of the export market. In addition OPEC, in December 1985, adopted a similar policy objective of capturing world market share by price competition. These two moves flooded the world market with excess oil, further exaggerating the excess availability problem. As soon as the winter demand for oil slackened in January 1986 prices began to plummet. The average worldwide price of exported crude fell from $27.10/bbl the first week of January 1986 to $9.35/bbl the first week of August 1986. This was a drop of $17.75/bbl, 65.5% in seven months. This forced OPEC to put together an informal quota agreement effective in September that helped prices move back up to $13-14/bbl throughout the remainder of 1986. A formal OPEC quota agreement in December helped push average export prices up over $17.50/bbl in 1987. Futures market prices, which are based on one high grade crude, moved over $20/bbl.

As mentioned oil product demand is relatively price inelastic. But a drop in price of the magnitude that occcurred in 1986 is sure to have a stimulative impact on demand and offset some conservation.

"Economic growth, energy demand, oil demand, energy prices, and oil prices are all interrelated and interdependent."

As a result non-communist world demand for petroleum products moved up 2.7% in 1986. Demand in the U.S. moved up 3.5%. Demand in Western Europe moved up 3.6% in 1986. Even in Japan, where oil conservation is a major economic objective, oil demand moved up 0.5% in 1986.

With oil prices rebounding in 1987, some of the stimulative impact on demand is lost. But prices are still much lower than in the early 1980's. This should at least have a mild stimulative impact and slow investment in oil and energy conservation.

Economic growth, energy demand, oil demand, energy prices, and oil prices are all interrelated and interdependent.

There are still a number of major problems that plague the worldwide economy. The major problems are the huge international debt, large budget deficits and unemployment. And there is a growing threat that a wave of protectionism may sweep over the industrialized areas and reduce world trade. Any and all of these could slow worldwide economic growth.

However, it appears that these problems are being contained at the present time and will not lead to a major slump in economic activity over the next five years. It is expected that worldwide economic activity will grow at an average rate of about 2.7% over the next five years of the forecast period. It is expected the economic activity will slow in 1988 and 1989 as the world adjusts to the debt problem.

However, relatively low energy prices are expected to be a positive stimulus to economic activity throughout the forecast period. In the early years, 1988 and 1989, the lower energy prices will prevent the worldwide economy from slipping into a recession. After the deficit and debt problems are resolved, the relatively low real price of oil and energy will help stimulate economic growth of 3 to 4% per year.

Although oil prices rebounded dur-

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ing the last part of 1986 and continued to move up in 1987, they were still well below the high prices of the 1980-1985 period. And even though current prices are expected to continue to move up throughout the forecast period, the real price adjusted for inflation will remain well below those peak price years.

Over the forecast period oil prices are projected to increase about 6.5% per year. Inflation is expected to be contained at 3 to 4% per year.

"Demand for all major types of petroleum products, including fuel oil, is expected to increase over the forecast period."

Continuing conservation will result in the energy growth rate being somewhat lower than the economic growth rate. However, the ratio of energy growth to economic growth will be greater than in recent years. Over the next five years, consumption of low-cost energy will be driving economic growth. Non-communist energy consumption will increase at a rate of about 1.7 to 1.8% per year over the forecast period, but will vary in any year with the pace of economic growth. World energy demand is forecast to increase 10.7% from 1987 to 1992. Non-communist demand is projected to increase 9%. Due to the lower current and real oil prices and petroleum product prices, the worldwide demand for oil will move up at a rate close to the rate of increase in overall energy demand.

Conservation is expected to continue throughout the forecast period but with lower energy prices the incentive is greatly reduced. Oil will be much more competitive with other fuels and will be able to retain its share of the total energy market.

Demand for all major types of petroleum products, including fuel oil, is expected to increase over the forecast period. At these lower prices fuel oil will retain a role of swing fuel for electric utilities and heavy industry.

Over the five-year forecast period 1988-1992, world oil demand is projected to increase 9.4% to 66.4 million b/d in 1992. This will be an increase of 5.68 million b/d. Non-communist oil demand is forecast to increase 9.1% to 51.34 million b/d.

Demand for motor gasoline is expected to move up 6.3% over the five years to 16.1 million b/d in 1992, for the non-communist countries. The increased vehicle fleet due to population growth and increased affluence is expected to more than offset the increased efficiency of the new vehicles. With lower real prices, discretionary conservation is also expected to diminish considerably.

Demand for middle distillates is projected to increase 10.9% over the forecast period to 17.54 million b/d in 1992. Middle distillate demand is very closely correlated to increased economic activity.

Fuel oil will be much more competitive than in past years. Demand for fuel oil will pick up if there is any slowing of completion of nuclear facilities, or if coal usage is curtailed due to "acid rain" environmental restraints. These issues are becoming global issues.

Demand for all other oil products is expected to move up 13.4% over the period to 9.05 million b/d in 1992. This includes asphalt for road construction, lubricants and petrochemical feedstocks.

THE OUTLOOK — WORLDWIDE DEMAND

	1986	1987	1988	1989	1990	1991	1992	Change 1987 to 1992	% change 1987 to 1992
WORLD ENERGY DEMAND (million barrels oil equivalent)									
Non-Communist	36,067	36,650	37,340	37,830	38,440	39,250	39,960	3,310	+ 9.0
Communist	19,563	20,150	20,650	21,060	21,690	22,230	22,890	2,740	+13.6
Total	**55,630**	**56,800**	**57,990**	**58,890**	**60,130**	**61,480**	**62,850**	**6,050**	**+10.7**
WORLD OIL DEMAND (thousand barrels day)									
Non-Communist	46,440	47,040	47,930	48,450	49,340	50,350	51,340	4,300	+ 9.1
Communist	13,480	13,680	13,930	14,230	14,530	14,810	15,060	1,380	+10.1
Total	**59,920**	**60,720**	**61,860**	**62,680**	**63,870**	**65,160**	**66,400**	**5,680**	**+ 9.4**
PETROLEUM PRODUCT DEMAND (thousand barrels day)									
Non-Communist areas									
Gasolines	14,990	15,140	15,255	15,400	15,670	15,870	16,100	960	+ 6.3
Middle distillates	15,565	15,810	16,270	16,455	16,755	17,200	17,540	1,730	+10.9
Fuel oil	8,030	8,110	8,310	8,390	8,520	8,570	8,650	540	+ 6.7
Others	7,855	7,980	8,095	8,205	8,395	8,710	9,050	1,070	+13.4
Crude oil price (average world export price) ($/barrel)	14.98	17.65	19.00	20.00	22.00	23.00	24.00	6.35	+36.0

Prices are projected to remain below the pre-1986 levels throughout the forecast period. Current dollar prices are projected to move up 36% over the forecast period to $24/bbl in 1992.

Prices will fluctuate with seasonal demand patterns and may be influenced by political factors. But it is expected that OPEC will not flood the market with low cost oil and instead will accept a gradual increase in price that will come with increased demand coupled with OPEC production constraints. The price increase will average about 6.4%/year over the forecast period.

"The real price will move up throughout the forecast period since the rate of inflation is projected at only 3 to 4%."

The real price will move up throughout the forecast period since the rate of inflation is projected at only 3 to 4%. But since the real price will remain well below the pre-1986 levels, it is expected to remain a positive stimulus to economic growth throughout the forecast period.

WORLDWIDE DEMAND

Keys to the Future

1. Debt, budget deficit and unemployment problems will be contained. Worldwide economic growth averaging 2.7%/year over the forecast period.

2. Continuing but slower improvement in energy conservation. Energy consumption increasing at 1.7% over the forecast period.

3. Crude oil prices move up 36% over the forecast period. But prices remain well below previous peak.

4. Demand for petroleum products is stimulated by lower prices and economic growth. World demand moves up an average of 1.8%/year.

5. Demand for light products leads the way. But lower prices also stimulate demand for fuel oil.

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Worldwide Outlook
Supply

THE SUPPLY SIDE OF THE EQUATION continues to dictate the path for the worldwide oil industry. The supply of crude oil made available on the worldwide industry is determining the price level, profitability, level of investment and type of activity in the industry.

"The abrupt shift in OPEC policy in 1986, from one concentrating on supporting price to a policy of gaining production market share, led to a sudden and precipitous drop in prices. With worldwide economic growth fueled by oil consumption, the first price hike only slowed consumption."

And OPEC, led by Saudi Arabia, is controlling the supply level to a substantial degree. OPEC learned a valuable economic lesson in 1986 and they now realize that some level of cooperation and restraint is essential if they are to optimize their income in today's market.

The abrupt shift in OPEC policy in 1986, from one concentrating on supporting price to a policy of gaining production market share, led to a sudden and precipitous drop in prices. Prior to adoption of the market share policy, the downward pressure on prices due to the worldwide surplus crude capacity had been somewhat alleviated by the willingness of Saudi Arabia and a few other OPEC countries to cut production. That effort did not totally prevent a decline in prices but it slowed the rate of decline.

"With worldwide economic growth fueled by oil consumption, the first price hike only slowed consumption."

The 1986 policy flooded the market with inexpensive crude and allowed prices to free fall. And it led to export crude prices lower than anyone would have dreamed of forecasting a few years earlier.

Having acquired some "newly discovered" economic wisdom from this market experiment, OPEC reestablished a quota system in the latter part of 1986. First they adopted an emergency temporary set of quotas in September 1986. They then adopted a formal quota agreement that tightened up supply and boosted prices again.

In order to reestablish the pre-1986 prices, quotas would have to be slashed to what appears to be unacceptably low levels. And the price is now very close to the level Saudi Arabia had determined would lead to steady long-term growth in oil demand. Although the trip was not without turmoil, a desirable price level may now have been achieved. At least a price level desired by Saudi Arabia and some of the other OPEC members with huge reserves.

REVIEW

PRODUCTION. Worldwide economic activity expanded greatly with little interruption throughout the 1950's, 1960's and into the 1970's. A substantial proportion of the economic activity and growth was fueled by crude oil. Worldwide production of crude oil expanded steadily throughout this period to meet the ever-increasing demand.

New field development and capacity additions were sustained at a pace similar to that of economic growth and demand for oil.

But two price hikes, the first in 1973-1974 and the second in 1979-1981, put an end to this steady climb in crude production. With worldwide economic growth fueled by oil consumption, the first price hike only slowed consumption. But it did give rise to more serious thought and investment in energy conservation.

The second, and larger, price hike stopped the growth in oil consumption and production in its tracks. The second major price increase occurred in the

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1979-1981 period and was the major reason for the decrease in consumption and production of oil that followed. Not only were conservation steps taken to reduce energy costs, but these adjustments led to a slow-down in economic activity, which contributed further to a drop in demand for oil.

Total hydrocarbon liquids production (crude oil, condensate and natural gas liquids) peaked in 1979 at 65.775 million barrels per day. Production in the non-communist world also peaked in 1979 at 51.28 million barrels per day. The increased cost of oil forced conservation, and world production fell for four consecutive years, 1979-1983, dropping to 56.685 million b/d in 1983. This was a drop in production of 9.09 million b/d, or 13.8%.

"With declining demand for crude oil products and therefore for crude production, prices began to slide in the last half of 1981."

The drop in world crude production mirrored the drop in demand for petroleum products. The latter was a direct result of the sharp increase in the price of oil products, resulting from the OPEC crude price increases. In addition, there was a rapid shift to other energy sources for fueling economic growth. Although the costs of other energy forms were also on the rise, they were not increasing as rapidly. Oil led the way and became the highest-cost energy form for many activities.

Non-communist production, which is more sensitive to market forces, fell 9.74 million b/d (19%) to 41.54 million b/d. Communist area production actually continued to rise over this period, increasing from 14.495 million b/d in 1979 to 15.145 million b/d in 1983.

With declining demand for crude oil products and therefore for crude production, prices began to slide in the last half of 1981. With weak demand relative to supply, prices slid downward gradually throughout the 1981-1985 period. Prices broke downward sharply in 1986 and this will be discussed more completely later.

These lower prices slowed conservation efforts and slightly stimulated demand over the 1981-1985 period.

There was a slight rebound in production, both total world and non-communist, in 1984. Non-communist production increased 1.33 million b/d, 3.2%, to 42.87 million b/d. Total world output increased 1.42 million b/d, up 2.5% to 58.105 million b/d. Lower crude oil prices and increased economic growth wre the major reasons for this increase in production. Production slipped slightly in 1985. Total non-communist production dropped 0.9% to 42.49 million b/d. Total world output fell to 57.62 million b/d. Last year, stimulated by low prices, the demand for crude oil pushed world production to 60.19 million b/d, up 4.5%. This was the first time total liquids output was over 60 million b/d since 1980.

OPEC PRODUCTION AND CAPACITY. The initial drop in prices in 1981-1983 was mainly due to the development of a massive excess crude oil capacity worldwide. Both increased output in non-OPEC countries and the drop in demand contributed to the excess capacity. In fact, the real key to understanding the world oil supply situation and crude oil price developments is understanding the worlwide crude production capacity situation.

Over time, as more and more oil was required to fuel worldwide economic

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WORLDWIDE OIL RESERVES

	1975	1976	1977	1978	1979	1980	Jan. 1 1981	1982 (1,000 bbl)	1983	1984	1985	1986	1987	Change 1987-1977	% change 1987/1977
Australia	2,300,000	1,700,080	1,380,000	2,000,000	2,100,000	2,130,000	2,360,000	1,709,000	1,622,077	1,586,000	1,430,900	1,449,000	1,712,800	+332,800	+24.1
Brunei	2,500,000	2,000,000	1,625,000	1,550,000	1,480,000	1,800,000	1,710,000	1,630,000	1,240,000	1,390,000	1,400,000	1,480,000	1,420,900	−204,100	−12.6
India	834,000	913,000	3,000,000	3,000,000	2,900,000	2,600,000	1,710,000	2,672,000	3,416,400	3,485,000	3,500,000	3,736,000	4,202,800	+1,202,800	+40.1
Indonesia	15,000,000	14,000,000	10,500,000	10,000,000	10,200,000	9,600,000	9,500,000	9,800,000	9,550,000	9,100,000	8,650,000	8,500,000	8,300,000	−2,200,000	−21.0
Malaysia	-	2,500,000	2,430,000	2,500,000	2,800,000	2,800,000	3,000,000	2,800,000	3,325,000	3,000,000	3,000,000	3,100,000	2,820,500	+390,500	+16.1
Others	413,700	121,230	456,140	699,270	527,200	425,200	480,500	541,800	602,600	408,400	549,000	591,300	566,500	+110,360	+24.2
Total Asia-Pacific	**21,047,700**	**21,234,230**	**19,391,140**	**19,479,270**	**20,007,200**	**19,355,200**	**19,630,500**	**19,150,800**	**19,756,077**	**18,969,400**	**18,529,900**	**18,856,300**	**19,023,500**	**−367,640**	**−1.9**
Norway	7,300,000	7,000,000	5,660,000	6,000,000	5,900,000	5,750,000	5,500,000	7,620,000	6,800,000	7,660,000	8,300,000	10,900,000	10,500,000	+4,840,000	+85.7
United Kingdom	15,700,000	16,000,000	16,800,000	19,000,000	16,000,000	15,400,000	14,800,000	14,800,000	13,990,000	13,150,000	13,590,000	13,000,000	9,000,000	−7,800,000	−46.4
Others	2,814,000	2,487,700	2,078,810	1,862,500	2,066,000	2,626,400	2,785,000	2,214,500	2,223,680	2,209,480	2,535,500	2,512,600	2,438,050	+359,240	+17.3
Total Western Europe	**25,814,000**	**25,487,700**	**24,538,810**	**26,862,500**	**23,966,000**	**23,776,400**	**23,085,000**	**24,634,500**	**22,923,680**	**23,019,480**	**24,425,500**	**26,412,600**	**21,938,050**	**−2,600,760**	**−10.6**
Abu Dhabi	30,000,000	29,500,000	29,000,000	31,000,000	30,000,000	28,000,000	29,000,000	30,600,000	30,510,000	30,400,000	30,500,000	31,000,000	31,000,000	+2,000,000	+6.9
Divided Zone	6,400,000	6,300,000	6,200,000	6,480,000	6,260,000	6,060,000		6,500,000	5,840,000	5,695,000	5,420,000	5,380,000	5,212,100	−1,087,900	−17.3
Dubai	2,420,000	1,350,000	1,500,000	1,400,000	1,300,000	1,400,000	1,400,000	1,270,000	1,440,000	1,440,000	1,440,000	1,400,000	1,350,000	−150,000	−10.0
Iran	66,000,000	64,500,000	63,000,000	62,000,000	59,000,000	58,000,000	57,500,000	57,000,000	55,308,000	51,000,000	48,500,000	47,876,000	48,800,000	−14,200,000	−22.5
Iraq	35,000,000	34,300,000	34,000,000	34,500,000	32,100,000	31,000,000	30,000,000	29,700,000	41,000,000	43,000,000	44,500,000	44,110,000	47,100,000	+13,100,000	+38.5
Kuwait	72,800,000	68,000,000	67,400,000	67,000,000	66,200,000	65,400,000	64,900,000	64,480,000	64,230,000	63,900,000	90,000,000	89,774,000	91,916,000	+21,516,000	+36.4
Oman	6,000,000	5,900,000	5,800,000	5,650,000	2,500,000	2,400,000	2,340,000	2,570,000	2,730,000	2,790,000	3,500,000	4,000,000	4,032,000	−1,768,000	−30.5
Qatar	6,000,000	5,850,000	5,700,000	5,600,000	4,000,000	3,760,000	3,585,000	3,434,000	3,425,000	3,330,000	3,350,000	3,300,000	3,154,000	−2,546,000	−44.7
Saudi Arabia	164,500,000	148,600,000	151,400,000	150,000,000	165,700,000	163,350,000	165,000,000	164,600,000	162,400,000	166,000,000	169,000,000	168,800,000	166,573,900	+15,173,900	+10.0
Syria	1,500,000	2,240,000	2,200,000	2,150,000	2,080,000	2,000,000	1,940,000	1,890,000	1,521,000	1,490,000	1,450,000	1,440,000	1,400,000	−800,000	−36.4
Others	2,338,200	1,770,570	1,380,000	666,000	636,000	377,300	346,000	795,950	881,893	1,055,800	720,750	945,710	1,340,700	−39,300	−2.8
Total Middle East	**403,858,200**	**368,410,570**	**367,680,000**	**366,166,000**	**369,996,000**	**361,947,300**	**362,071,000**	**362,839,950**	**369,285,893**	**370,100,800**	**398,380,750**	**398,025,710**	**401,878,700**	**+34,198,700**	**+9.3**
Algeria	7,700,000	7,370,000	6,800,000	6,600,000	6,300,000	8,440,000	8,200,000	8,080,000	9,440,000	9,220,000	9,000,000	8,820,000	8,800,000	+2,000,000	+29.4
Angola-Cabinda	1,175,000	1,300,000	1,210,000	1,160,000	1,115,000	1,200,000	1,200,000	1,450,000	1,635,000	1,700,000	1,800,000	2,000,000	1,149,400	−60,600	−5.0
Congo Republic	4,874,000	2,450,000	285,000	360,000	315,000	400,000	660,000	1,300,000	1,550,000	400,000	480,000	650,000	720,000	+435,000	+152.6
Egypt	3,700,000	3,900,000	1,950,000	2,450,000	3,200,000	3,100,000	2,900,000	2,930,000	3,325,000	3,450,000	3,200,000	3,850,000	3,600,000	+1,650,000	+84.6
Libya	26,600,000	26,100,000	25,500,000	25,000,000	24,300,000	23,500,000	23,000,000	22,600,000	21,500,000	21,270,000	21,100,000	21,300,000	21,300,000	−4,200,000	−16.5
Nigeria	20,900,000	20,200,000	19,500,000	18,700,000	18,200,000	17,400,000	16,700,000	16,500,000	16,750,000	16,550,000	16,650,000	16,600,000	16,000,000	−3,500,000	−17.9
Tunisia	1,100,000	1,065,000	2,700,000	2,670,000	2,300,000	2,250,000	1,652,000	1,690,000	1,860,000	1,820,000	1,514,000	1,800,000	1,800,000	+900,000	+33.3
Others	2,250,450	2,700,220	2,625,200	2,260,150	2,162,125	782,100	836,375	1,621,630	1,761,690	2,497,020	1,796,550	1,714,050	1,824,650	−800,550	−30.5
Total Africa	**68,299,450**	**65,085,220**	**60,570,200**	**59,200,150**	**57,892,125**	**57,072,100**	**55,148,375**	**56,171,630**	**57,821,690**	**56,907,020**	**55,540,550**	**56,734,050**	**55,194,050**	**−5,376,150**	**−8.9**
Argentina	2,346,000	2,465,000	2,300,000	2,503,000	2,400,000	2,400,000	2,457,000	2,650,000	2,590,000	2,428,700	2,266,000	2,300,000	2,270,000	−30,000	−1.3
Brazil	775,000	780,000	800,000	880,000	1,200,000	1,220,000	1,300,000	1,325,060	1,750,000	1,800,000	1,976,000	2,070,000	2,250,000	+1,450,000	+181.3
Ecuador	2,500,000	2,450,000	1,700,000	1,640,000	1,170,000	1,100,000	1,100,000	850,000	1,400,000	1,675,000	1,400,000	1,650,000	1,672,300	−27,700	−1.6
Mexico	13,582,000	9,500,000	7,000,000	14,000,000	16,000,000	31,250,000	44,000,000	56,990,000	48,300,000	48,000,000	48,600,000	49,300,000	54,653,000	+47,653,000	+680.8
Venezuela	15,000,000	17,700,000	15,270,000	18,200,000	18,000,000	17,870,000	17,950,000	20,300,000	21,500,000	24,850,000	25,845,000	25,591,000	25,000,000	+9,730,000	+63.7
United States	35,299,839	33,000,000	31,300,000	29,500,000	28,500,000	26,500,000	26,400,000	29,785,000	29,785,000	27,300,000	27,300,000	6,500,000	24,560,000	−6,740,000	−21.5
Canada	9,400,000	7,100,000	6,200,000	6,000,000	6,000,000	6,800,000	6,400,000	7,300,000	7,020,000	6,730,000	7,075,000	28,000,000	6,850,000	+650,000	+10.5
Others	6,375,000	2,473,000	2,538,950	3,147,000	2,476,500	2,632,500	2,682,837	2,867,210	2,942,066	2,922,200	3,228,700	3,331,400	2,870,000	+331,050	+13.0
Total Western Hemisphere	**85,277,839**	**75,468,000**	**67,108,950**	**75,870,000**	**75,746,500**	**89,772,500**	**102,289,837**	**122,067,270**	**115,287,066**	**115,705,900**	**117,690,700**	**118,742,400**	**120,125,300**	**+53,016,350**	**+79.0**
Total Non-Communist	**604,297,189**	**555,685,720**	**539,290,000**	**547,847,920**	**547,607,825**	**551,623,500**	**562,224,712**	**584,864,150**	**585,074,406**	**584,702,600**	**614,567,400**	**618,771,060**	**618,199,600**	**+78,909,600**	**+14.6**
China	25,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	29,500,000	19,895,000	19,485,000	19,100,000	19,100,000	18,420,000	18,400,000	−1,600,000	−8.0
U.S.S.R.	83,400,000	80,400,000	78,100,000	75,000,000	71,000,000	67,000,000	63,000,000	63,000,000	63,000,000	63,000,000	63,000,000	61,000,000	59,000,000	−19,100,000	−24.5
Others	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	2,800,000	2,950,000	2,630,000	2,500,000	2,000,000	1,950,000	1,850,000	−1,150,000	−38.3
Total Communist	**111,400,000**	**103,400,000**	**101,100,000**	**98,000,000**	**94,000,000**	**90,000,000**	**86,300,000**	**85,845,000**	**85,115,000**	**84,600,000**	**84,100,000**	**81,370,000**	**79,250,000**	**−21,850,000**	**−21.6**
Total World	**715,697,189**	**659,085,720**	**640,390,000**	**645,847,920**	**641,607,825**	**641,623,500**	**648,524,712**	**670,709,150**	**670,189,406**	**669,302,600**	**698,667,400**	**700,141,060**	**697,449,600**	**+57,059,600**	**+8.9**
Total OPEC	**485,306,000**	**450,182,000**	**440,685,000**	**440,185,000**	**445,186,000**	**435,831,300**	**434,580,000**	**436,709,000**	**436,858,000**	**448,420,000**	**476,415,000**	**475,211,000**	**478,923,300**	**+38,238,300**	**+8.7**
OPEC as % of world	67.8%	68.3%	68.9%	68.2%	69.4%	68.0%	67.1%	65.2%	65.2%	67.0%	68.2%	67.9%	68.7%	—	—

*Included in Brunei. †Government figure. Later revised significantly downward.

Source: Oil & Gas Journal

growth, production capacity was expanded to meet the demand. Production facilities were installed to allow a buffer for maintenance and other non-routine contingencies. Generally, output was planned to average about 92% of installled capacity. The international oil companies, as a rule, obtained concessions and developed the lower-cost areas first. These were the prolific fields of the OPEC countries. Capacity seldom exceeded demand because the rate of installation of new capacity was regulated to meet demand growth

As demand for oil increased throughout the 1960's and into the 1970's, it was increasing production from the OPEC countries that filled the need. By 1976, OPEC output represented 51.8% of total worldwide output, and 65.6% of non-communist world demand.

"The Iranian revolution helped drop excess capacity to the 9-10% level and allowed OPEC to push through the massive 1979-1980 price increase."

OPEC production actually peaked in 1977 at 31.68 million b/d, 50.6% of worldwide production, and 64.5% of non-communist production. OPEC output remained above 30 million b/d in 1978 and 1979, with 1979 at 31.47 million b/d. This was 47.8% of total world demand and 61.4% of non-communist demand.

OPEC was beginning to lose a part of its market share because the rapid rise in prices had stimulated the development of crude production in non-OPEC countries, and non-OPEC output was beginning to supply a greater proportion of demand.

The development of the present-day excess capacity situation actually started earlier. In the late 1960's and early 1970's, as worldwide demand was on the rise, the OPEC countries gained control of their oil resources from the international oil companies. The international oil companies had been efficient at exploration and production. The price was kept low by continuous development of additional oil resources in the face of rising demand. When OPEC gained control, they took advantage of the dependence on oil and the worldwide economic expansion that was being fueled by oil. They chose to test the demand response to higher prices (elasticity of demand), and raised prices sharply in 1973-1974. Demand continued to rise, so they boosted prices again in 1979-1981.

These price hikes had a dramatic impact on the production capacity situation worldwide, but particularly in the OPEC countries.

Through the 1960's and up until 1973, excess capacity in the worldwide oil industry was 7-8%. Excess capacity was 7% of total capacity and 8% of production. After the price hike, excess capacity began to increase, moving up to 10-12% in 1974 and as high as 19-25% in 1975. This was 19% of available capacity and 25% of production. The Iranian revolution helped drop excess capacity to the 9-10% level and allowed OPEC to push through the massive 1979-1980 price increase.

But, following 1979, the combination of declining demand and rising non-OPEC production has resulted in massive excess capacity. Most OPEC capacity had been put in place by 1977, but non-OPEC production had been stimulated by the increase in prices, and new capacity added continuously. Only the Iranian revolution and the Iran-Iraq War kept the excess capacity situation

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in check. But by 1983 excess capacity was 15.6 million b/d, which was 29% of total capacity and 41% of total production/demand.

Excess capacity dropped only marginally in 1984 to 15.3 million b/d. This was still 28% of total available non-communist capacity and 39% of total production. This excludes about 7 million b/d shut in due to the Iran-Iraq War. It is difficult to determine how much of that 7 million b/d is still available, but a substantial proportion could probably be brought back on stream if required.

"OPEC adopted a very aggressive pricing policy when demand and capacity were in line."

In 1985, excess capacity moved up again to 15.6 million b/d. This represented 29% of total non-communist oil production capacity, and about 40% of total oil production. In 1986 the excess capacity fell slightly to 14.1 million b/d. This is 26% of total capacity and 35% of total production.

"In response to the higher prices engineered by OPEC, the production in non-OPEC, non-communist countries increased steadily from 1975 through 1985."

There is growing evidence that about 5 million b/d of the 7 million b/d shut in due to the Iran-Iraq War should not be considered in the analysis of excess capacity. It would take a considerable period of time to bring any of that capacity back on stream and therefore, it has little impact on current economics.

If that capacity is removed, total non-communist capacity is lowered to 49.55 million b/d in 1986. And the excess capacity drops to 9.096 million b/d. But this is still 18.4% of total capacity and 22.5% of production. This is still sufficient excess capacity to continue to put downward pressure on prices. This massive excess production capacity has been putting downward pressure on prices since 1981. It has been the major reason for the steady decline in prices since early 1981.

OPEC adopted a very aggressive pricing policy when demand and capacity were in line. Because of that policy, when demand began to fall, it was at the expense of OPEC output. As stated, OPEC production peaked in 1977 at 31.7 million b/d. This was 64.5% of free-world production. In 1982, for the first time in its history, OPEC production fell below 50% of free-world production. In that year, OPEC output was 19.93 million b/d, 47.4% of free-world output.

By 1984, OPEC production had fallen to 18.5 million b/d, a drop of 41.7%. This was only 43% of total free-world production. And in 1985, OPEC production fell another 6.8% to 17.215 million b/d. This was only 40.5% of non-communist output, and 29.9% of total world production. OPEC output had fallen 45.7% from the 1977 peak, a drop of 14.465 million b/d. This drastic drop in market share is one of the reasons OPEC tried adopting a market share policy in 1986. And with sharply lower prices demand for OPEC oil rebounded in 1986, jumping up 12.9% to total liquids output of 19.44 million b/d.

NON-OPEC PRODUCTION. But the OPEC countries are not the only crude oil producers in the world. In response to the higher prices engineered by OPEC, the production in non-OPEC, non-communist countries increased steadily from 1975 through 1985. This is a classical economic supply response to markedly higher prices.

Non-OPEC non-communist produc-

WORLDWIDE OIL PRODUCTION*

Country Area	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	% change 86/76	% change 86/79
						(1,000 b/d)							
NORTH AMERICA													
U.S.	9,735	9,865	10,275	10,135	10,170	10,180	10,200	10,245	10,505	10,545	10,235	5.1	1.0
Canada	1,605	1,610	1,575	1,770	1,725	1,545	1,485	1,515	1,645	1,815	1,795	11.8	1.4
Total North America	**11,340**	**11,475**	**11,850**	**11,905**	**11,895**	**11,725**	**11,685**	**11,760**	**12,150**	**12,360**	**12,030**	**6.1**	**1.0**
LATIN AMERICA													
Argentina	390	430	455	470	490	490	490	475	465	460	430	10.3	-8.5
Brazil	170	165	165	170	195	220	275	365	460	585	615	261.8	261.8
Colombia	145	140	130	150	125	135	145	155	170	175	320	120.7	113.3
Ecuador	185	190	205	215	205	210	200	240	255	275	275	48.6	27.9
Mexico	875	1,085	1,330	1,630	2,155	2,585	3,005	2,950	3,015	3,015	2,745	213.7	68.4
Trinidad	215	230	230	215	210	200	175	165	170	175	170	20.9	20.9
Venezuela	2,375	2,315	2,235	2,425	2,235	2,180	1,965	1,875	1,875	1,730	1,845	22.3	23.9
Others	150	160	215	255	280	275	295	260	270	270	250	66.7	-2.0
Total Latin America	**4,505**	**4,715**	**4,965**	**5,530**	**5,895**	**6,295**	**6,550**	**6,485**	**6,680**	**6,685**	**6,650**	**47.6**	**20.3**
WESTERN EUROPE													
Austria	40	35	35	35	30	25	25	25	25	25	25	-37.5	-28.6
Denmark	5	10	10	10	5	15	35	45	45	60	75	1,400.0	650.0
France	20	20	20	25	30	35	50	50	60	70	70	250.0	180.0
Italy	20	20	25	30	35	25	30	40	40	45	45	125.0	50.0
Norway	280	275	350	385	525	505	530	660	755	835	910	225.0	136.4
Turkey	50	55	55	55	45	45	45	45	40	40	45	-10.0	-18.2
United Kingdom	240	765	1,095	1,600	1,650	1,835	2,125	2,360	2,580	2,655	2,665	1,010.4	66.6
West Germany	110	105	100	95	90	90	85	80	80	80	80	-27.3	-15.8
Others	65	45	45	60	65	60	95	145	140	150	160	146.2	166.7
Total Western Europe	**830**	**1,330**	**1,735**	**2,295**	**2,475**	**2,635**	**3,020**	**3,450**	**3,765**	**3,960**	**4,075**	**391.0**	**77.6**
MIDDLE EAST													
Abu Dhabi	1,595	1,665	1,450	1,465	1,345	1,135	885	830	825	890	1,080	-32.3	-26.3
Dubai	315	320	360	355	350	360	360	345	375	390	390	23.8	9.9
Iran	5,920	5,705	5,275	3,175	1,480	1,325	2,410	2,465	2,195	2,215	1,885	-68.2	-40.6
Iraq	2,415	2,350	2,560	3,475	2,645	895	1,010	1,105	1,225	1,440	1,725	-28.6	-50.4
Kuwait	1,965	1,835	1,945	2,270	1,430	965	705	900	985	920	1,250	-36.4	-44.9
Neutral Zone	465	390	470	570	545	375	315	310	405	340	345	-25.8	-39.5
Oman	365	340	315	295	285	325	325	390	420	505	560	53.4	89.8
Qatar	495	445	485	510	460	425	340	310	425	340	350	-29.3	-31.4
Saudi Arabia	8,525	9,235	8,315	9,555	9,990	9,985	6,695	5,225	4,760	3,565	5,145	-39.6	-46.2
Others	290	260	250	240	225	225	230	230	240	295	320	10.3	33.3
Total Middle East	**22,350**	**22,545**	**21,425**	**21,910**	**18,755**	**16,015**	**13,275**	**12,110**	**11,855**	**10,900**	**13,050**	**-41.6**	**-40.4**
AFRICA													
Algeria	1,075	1,150	1,230	1,255	1,120	1,035	1,045	980	1,075	970	990	-7.9	-21.1
Egypt	325	415	480	525	590	690	705	725	860	905	820	152.3	56.2
Libya	1,930	2,065	1,985	2,090	1,830	1,220	1,135	1,110	1,105	1,105	1,070	-44.6	-48.8
Other North Africa	75	100	100	115	120	115	105	115	120	105	105	40.0	-8.7
Gabon	225	220	210	205	175	150	155	155	150	155	160	-28.9	-22.0
Nigeria	2,065	2,085	1,895	2,300	2,055	1,440	1,285	1,235	1,385	1,475	1,455	-29.5	-36.7
Other West Africa	165	230	195	260	285	330	355	420	510	580	625	278.8	140.4
Total Africa	**5,860**	**6,265**	**6,095**	**6,750**	**6,175**	**4,980**	**4,785**	**4,740**	**5,205**	**5,295**	**5,225**	**-10.8**	**-22.6**
ASIA AND AUSTRALASIA													
Japan	10	10	10	10	10	10	10	10	10	10	10	—	—
Brunei	205	220	205	240	235	175	165	175	160	150	150	-26.8	-37.5
Indonesia	1,505	1,690	1,635	1,590	1,575	1,680	1,415	1,345	1,410	1,335	1,400	-7.0	-11.9
Malaysia	165	185	215	285	275	250	295	420	440	435	505	206.1	77.2
Other Southeast Asia	5	10	5	10	15	10	15	25	35	55	50	900.0	400.0
South Asia	200	240	260	300	230	340	440	550	610	670	695	247.5	131.7
Australasia†	430	450	450	455	400	410	420	470	550	635	730	69.8	60.4
Total Asia and Australasia	**2,520**	**2,805**	**2,780**	**2,890**	**2,740**	**2,875**	**2,760**	**2,995**	**3,215**	**3,290**	**3,540**	**40.5**	**22.5**
Total Non-Communist World	**47,405**	**49,135**	**48,850**	**51,280**	**47,935**	**44,525**	**42,075**	**41,540**	**42,870**	**42,490**	**44,570**	**-6.0**	**-13.1**
COMMUNIST													
China	1,675	1,880	2,090	2,130	2,125	2,035	2,050	2,135	2,300	2,515	2,630	57.0	23.5
U.S.S.R.	10,520	11,055	11,595	11,870	12,215	12,370	12,430	12,520	12,450	12,150	12,515	19.0	5.4
Others	480	490	515	495	470	445	505	490	485	465	475	-1.0	4.0
Total Communist	**12,675**	**13,425**	**14,200**	**14,495**	**14,810**	**14,850**	**14,985**	**15,145**	**15,235**	**15,130**	**15,620**	**23.2**	**7.8**
Total World	**60,080**	**62,560**	**63,050**	**65,775**	**62,745**	**59,375**	**57,060**	**56,685**	**58,105**	**57,620**	**60,190**	**0.2**	**-8.5**
OPEC	31,100	31,680	30,280	31,465	27,445	23,380	19,930	18,425	18,470	17,215	19,440	-37.5	-38.2

*Includes natural gas liquids
†Includes Australia and New Zealand

Source: British Petroleum

tion increased 55.5% from 16.255 million b/d in 1975 to 25.275 million b/d in 1985. Obviously, the OPEC-led increase in prices made oil production economical in a number of other areas of the world. The increases in non-OPEC production occurred throughout the world. Major increases have been recorded in Brazil and Mexico in the Western Hemisphere. Norway and the United Kingdom have boosted production substantially in Western Europe. Elsewhere, there have been large increases in Egypt and India. A number of these countries have become major exporters of crude oil and are in direct competition with the OPEC exporters.

"With Chinese production also on the rise, total communist production moved up to 15.62 million b/d in 1986, up 31.2% since 1975."

Non-OPEC production fell slightly in 1986, declining 0.6%, 145,000 b/d, down to 25.13 million b/d. Most of the decline was attributable to the drop in U.S. liquids output due to the sharp fall in prices. Much of the U.S. production in older smaller fields is high cost output. Therefore, production was shut in when prices dipped.

"OPEC production, particularly in the Persian Gulf area, is some of the lowest cost in the world. But the aggressive pricing policies of OPEC resulted in OPEC oil being the highest priced in the world."

In addition to increasing non-OPEC non-communist production, the U.S.S.R. has been increasing production and exports. This has added to the crude glut and increased the impact on OPEC. U.S.S.R. output moved up 26% between 1975 and 1983. They are the world's largest producer. Their production fell 3% to 12.15 million b/d in 1985 and there is some question how long this level of production can be sustained. However they did manage to boost production back up to 12.515 million b/d in 1986.

In addition, they have a program to replace internal oil consumption with gas and maintain exports. This would continue to add an element to the excess-capacity situation in the market-oriented world.

With Chinese production also on the rise, total communist production moved up to 15.62 million b/d in 1986, up 31.2% since 1975.

EXCESS CAPACITY PROBLEM. It is this massive excess capacity, which developed in the OPEC countries, that has put a constant downward pressure on crude oil prices.

OPEC has tried to stabilize prices by establishing production quotas for individual countries and the group as a whole. However, few of the countries, other than Saudi Arabia, exhibited the production discipline necessary to make the quotas work. The willingness of Saudi Arabia and a few other OPEC members to show some restraint managed to prevent a much-earlier free fall in prices. But it was impossible to stablize prices, and they continued to slide downward from 1981 through 1985.

OPEC production, particularly in the Persian Gulf area, is some of the lowest cost in the world. But the aggressive pricing policies of OPEC resulted in OPEC oil being the highest priced in the world. The result has been that, wherever possible, OPEC oil supplies have been replaced by domestic crude or other, less costly, imported crude.

Therefore, OPEC has become the swing producer meeting the gap between demand and non-OPEC production. All excess capacity, except for some minor exceptions, has been thrust upon OPEC. About 47% of installed

OPEC capacity, 14 million b/d out of 30 million b/d was shut in during 1985. This improved slightly in 1986 to 12 million b/d out of 30 million b/d, or 40% of installed OPEC capacity shut in. The OPEC cartel pricing policies resulted in an oil industry turned upside down, with the cheapest production shut in and the most expensive production producing at full capacity.

"The OPEC cartel pricing policies resulted in an oil industry turned upside down, with the cheapest production shut in and the most expensive production producing at full capacity."

As stated in the 1985 Outlook, "Only OPEC's ability to maintain production quotas will prevent the price from collapsing." OPEC wasn't able to establish group production discipline. Saudi Arabia abandoned the role of sole swing producer, and the result was a collapse in prices in the spring of 1986. A lesson was learned in the market.

To get a better perspective on what has been happening in the world oil industry and world oil prices, it might be advantageous to take a look from the viewpoint of classical economic theory.

In classical theory, price is the determinant of supply and demand. When external forces create a situation where there is not equilibrium., i.e. demand and supply do not meet at a market clearing price, then there are economic forces at work attempting to move the market toward equilibrium.

Prior to the establishment of OPEC, there is some justification in assuming that the international oil companies held the price below the equilibrium price. This created a situation of excess demand. The oil companies met demand by concentrating on production, and pricing with respect to current production costs. Little emphasis was given to the long-run value of reserves in the ground. The result was a rapid increase in demand as cheap oil energy fueled economic expansion worldwide.

When OPEC gained control over production, they placed more emphasis on the long-term value and life of their oil reserves. They attempted to maximize immediate return rather than output. And they were searching for the price level the market would bear. To a certain extent, OPEC was using the world as a large economic laboratory to test the elasticity of demand for crude oil. The result of OPEC's pricing policy was reduced demand and increased supply, netting out to an excess-supply situation.

However, market forces began to take hold and movement started toward reestablishing equilibrium. This movement took the form of falling prices, increased demand and a reduction in the rate of increase in the non-OPEC crude supply. A brief review of what happened to prices over the past fifteen years will help clarify this classical description.

The official posted price of the OPEC market crude, Saudi Arabian light, was first boosted 294.2% from $2.75/bbl in 1973 to $10.84/bbl in 1974. The demand response was minimal, since oil was already underpriced. Then the price moved up slowly to $12.70/bbl in 1978, an additional increase of 17.2%. Because of the sharp increase in the rate of inflation over this period, the real price actually fell during this period. Demand for crude oil continued to move up even though the actual price had increased substantially. Demand is more responsive to

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WORLDWIDE NATURAL GAS PRODUCTION

(Billion cu ft)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	% change 86/76
NORTH AMERICA												
U.S.	19,098	19,165	19,122	19,663	19,404	19,181	17,758	16,033	17,393	16,366	15,911	−16.7
Canada	2,717	2,850	2,744	2,944	2,709	2,642	2,606	2,454	2,427	2,623	2,623	−3.5
Total North America	**21,815**	**22,015**	**21,866**	**22,607**	**22,113**	**21,823**	**20,354**	**18,487**	**19,820**	**18,989**	**18,534**	**−15.0**
LATIN AMERICA												
Argentina	259	267	274	255	278	294	341	365	474	498	494	90.7
Bolivia	63	63	67	78	82	98	102	98	90	90	102	61.9
Chile	141	133	125	122	98	82	110	106	102	94	90	−36.2
Mexico	576	725	862	917	1,066	1,227	1,282	1,231	1,035	953	909	57.8
Trinidad	78	59	74	114	86	86	86	106	122	114	125	60.3
Venezuela	478	525	521	576	588	588	600	553	612	608	615	28.7
Others	130	153	159	172	170	185	200	234	265	273	273	110.0
Total Latin America	**1,725**	**1,925**	**2,082**	**2,234**	**2,368**	**2,560**	**2,721**	**2,693**	**2,700**	**2,630**	**2,608**	**51.2**
WESTERN EUROPE												
France	259	278	286	282	274	259	243	216	208	176	137	−47.1
Italy	612	455	486	474	404	455	498	435	459	486	561	−8.3
Netherlands	2,885	2,873	2,630	2,775	2,701	2,650	2,285	2,395	2,411	2,524	2,297	−20.4
Norway	12	102	525	760	925	921	898	898	972	894	953	7,841.7
United Kingdom	1,321	1,380	1,321	1,341	1,254	1,250	1,196	1,200	1,305	1,454	1,521	15.1
West Germany	553	564	604	604	553	564	494	514	537	478	435	−21.3
Others	81	67	87	87	90	86	46	46	66	161	192	137.0
Total Western Europe	**5,723**	**5,739**	**5,939**	**6,323**	**6,201**	**6,185**	**5,660**	**5,704**	**5,958**	**6,173**	**6,096**	**6.5**
MIDDLE EAST												
Abu Dhabi	47	114	176	220	204	212	216	220	227	231	251	434.0
Iran	760	741	686	706	294	255	255	388	478	478	490	−35.5
Kuwait	196	212	220	306	243	188	145	169	172	180	180	−8.2
Saudi Arabia	239	282	333	412	517	898	372	329	459	478	533	123.0
Others	236	243	247	379	388	329	364	325	404	428	428	81.4
Total Middle East	**1,478**	**1,592**	**1,662**	**2,023**	**1,646**	**1,882**	**1,352**	**1,431**	**1,740**	**1,795**	**1,882**	**27.3**
AFRICA												
Algeria	349	306	490	917	757	866	941	1,258	1,192	1,317	1,239	255.0
Libya	133	137	180	239	184	141	141	118	133	161	165	24.1
Nigeria	24	20	12	47	39	63	43	51	59	51	43	79.2
Others	31	39	47	63	71	71	110	125	164	199	199	541.9
Total Africa	**537**	**502**	**729**	**1,266**	**1,051**	**1,141**	**1,235**	**1,552**	**1,548**	**1,728**	**1,646**	**206.5**
ASIA AND AUSTRALASIA												
Japan	86	98	94	86	78	74	71	74	74	78	74	−14.0
Indonesia	82	200	384	557	655	678	694	780	1,168	1,227	1,341	1,535.4
Other Southeast Asia	388	404	392	392	419	435	463	502	545	670	662	70.6
Pakistan	184	208	208	200	243	239	310	337	357	365	388	110.9
Other South Asia	182	204	204	196	220	260	359	404	494	506	521	186.3
Australasia*	274	329	349	384	427	466	494	533	545	600	659	140.5
Total Asia and Australasia	**1,196**	**1,443**	**1,631**	**1,815**	**2,042**	**2,152**	**2,391**	**2,630**	**3,183**	**3,446**	**3,645**	**204.8**
Total Non-Communist World	**32,474**	**33,216**	**33,909**	**36,268**	**35,421**	**35,743**	**33,723**	**32,497**	**34,949**	**34,761**	**34,411**	**6.0**
COMMUNIST												
China	392	423	486	490	478	455	392	423	427	451	463	18.1
USSR	11,337	12,219	12,713	13,861	14,904	16,143	17,691	18,910	20,713	22,685	24,202	113.5
Others	2,116	2,093	2,148	2,042	2,007	2,100	2,113	2,184	2,313	2,328	2,462	16.4
Total Communist	**13,845**	**14,735**	**15,347**	**16,393**	**17,389**	**18,698**	**20,196**	**21,517**	**23,453**	**25,464**	**27,127**	**95.9**
Total World	**46,319**	**47,951**	**49,256**	**52,661**	**52,810**	**54,441**	**53,919**	**54,014**	**58,402**	**60,225**	**61,538**	**32.9**

*Includes Australia and New Zealand

Source: British Petroleum

WORLD CRUDE OIL PRICES

Official Sales and Term Contracts (Dollars per barrel) (1 January)

Year	Total World	Total OPEC	Total Non-OPEC	Difference Non-OPEC-OPEC
1975-1978	— Not Available			
1979	13.08	13.03	13.44	+0.41
1980	28.84	28.30	31.94	+3.64
1981	35.49	34.82	38.54	+3.72
1982	34.18	34.13	34.35	+0.22
1983	33.00	33.54	31.72	−1.82
1984	28.61	28.59	28.65	+0.06
1985	28.33	28.43	28.16	−0.27
1986	27.10	27.81	26.14	−1.67
1986-July	11.10	11.12	11.07	−0.05
1987	16.24	16.10	16.44	+0.34
1987-July	17.68	17.41	18.12	+0.71
CHANGE 1981 to 1987				
Actual	−19.25	−18.72	−22.10	
Percentage	−54.2%	−53.8%	−57.3%	
CHANGE July 1986 to July 1987				
Actual	+6.58	+6.29	+7.05	
Percentage	+59.3%	+56.6%	+63.7%	

Source: Energy Information Administration

PRICE–ARABIAN LIGHT CRUDE

(U.S. dollars per barrel)

Year	Average government selling price*	Average spot market price	Difference
1975	10.46	10.70	+0.24
1976	11.51	11.63	+0.12
1977	12.09	12.43	+0.34
1978	12.70	13.00	+0.30
1979	13.34	29.89	+16.55
1980	26.00	35.69	+9.69
1981	32.00	34.30	+2.30
1982	34.00	31.76	−2.24
1983	34.00	28.80	−5.20
1984	29.00	27.80	−1.20
1985	29.00	26.60	−2.40
1986	28.00	23.00	−5.00
1986-July	11.59	8.63	−2.96
1987-Jan.	16.15	17.50	+1.35
1987-July	17.52	17.67	+0.15

*As of January 1 or July 1

Source: DOE and Shell Oil

NET BACK PRICING EXAMPLE

	$/barrel
Product revenues	18.50
Less: refining costs	2.50
Less: processing handling fee	2.00
Less: transport cost	1.50
Net back price of crude*	**12.50**

*The net back value varies depending on product revenues and costs

OECD* PETROLEUM STOCKS

(Million barrels)

	1978	1980	1981	1982	1983	1984	1985	1986	1981/1978 Change	1981/1978 % change	1986/1981 Change	1986/1981 % change
Canada	144	164	161	136	120	127	112	110	+17	+11.8	−51	−31.7
France	201	243	214	193	153	153	138	125	+13	+6.5	−89	−41.6
Italy	154	170	167	179	149	159	157	155	+13	+8.4	−12	−7.2
Japan	413	495	482	484	471	480	495	510	+69	+16.7	+28	+5.8
United Kingdom	157	168	143	125	119	113	123	124	−14	−8.9	−19	−13.3
United States	1,278	1,392	1,484	1,430	1,454	1,556	1,519	1,594	+206	+16.1	+110	+7.4
West Germany	238	319	297	272	250	240	233	253	+59	+24.8	−44	−14.8
Other OECD	537	636	583	557	542	536	508	552	+46	+8.6	−31	−5.3
Total OECD	**3,122**	**3,587**	**3,531**	**3,376**	**3,258**	**3,364**	**3,285**	**3,423**	**+409**	**+13.1**	**−108**	**−3.1**

*Organization of Economic Cooperation & Development

Source: Energy Information Administration

the real price.

Since demand was still rising, OPEC decided to raise prices again. This time, they boosted prices sharply from $12.70/bbl in 1978 to $34.00/bbl at the end of 1981, an additional increase of 167.7%. The overall price increase from 1973 through 1981 was +$31.25/bbl, up 1136.4%.

"The growth in excess capacity led to a shift in trading from contract to the spot market."

Demand reacted to this price increase. Conservation, fuel switching to other energy and a slow down in economic activity, led to a 19% drop in production in the non-communist world between 1979 and 1983. This drop in demand for oil, coupled with the increase in non-OPEC production, resulted in the huge excess capacity in the OPEC countries.

This excess capacity put substantial downward pressure on prices. The official OPEC market crude price fell to $28/bbl in 1985, a reduction of 17.6% from the peak $34 level. The average spot market price fell from $35.69/bbl in 1980 to an estimated $27.80/bbl in 1984, a drop of 22.1%. Free-world demand responded to this sharp drop in prices, and moved up 2.1% in 1984.

The growth in excess capacity led to a shift in trading from contract to the spot market. When prices moved up sharply in 1979-1981, spot market prices were well above official prices. The average spot market price in 1979 was $12.60/bbl higher than the contract price. This undoubtedly prompted OPEC to push up the official price. With the development of the excess capacity, spot market prices fell below official prices and led to the drop in official prices.

The volume of crude traded in the spot market grew substantially from 1981 to 1985. By 1985, the vast majority of transactions were spot market transactions or contract trades based on spot market prices. In addition, because of the more speculative nature of crude trading and prices, a futures market developed and is growing rapidly. In three years, the number of crude oil contracts traded on the New York Mercantile Exchange has taken off, with 350 million bbl in 1983, 1840 million bbl in 1984, 3981 million bbl in 1985, and 8314 million bbl in 1986.

As stated earlier, in an attempt to prevent a collapse of prices, OPEC established production quotas for each member country. OPEC set a production quota in 1983 of 17.5 million b/d. However, prices continued to slide and the production quota was reduced to 16 million b/d in 1984. There was considerable cheating, with a number of OPEC countries producing above their quotas.

Saudi Arabia was willing to play the role of swing producer and cut production sharply in order to support the worldwide price. Saudi production fell 6.39 million b/d, 64%, from 9.99 million b/d in 1980 to 3.6 million b/d in 1985. Other OPEC producers showed some restraint, and the result was a sufficient reduction in total production to prevent a free fall in prices.

But in the summer of 1985, Saudi production temporarily dipped below 2 million b/d in their role of swing producer. And it became apparent that with expected weak demand in 1986, their production would fall even further if they continued to be the supply

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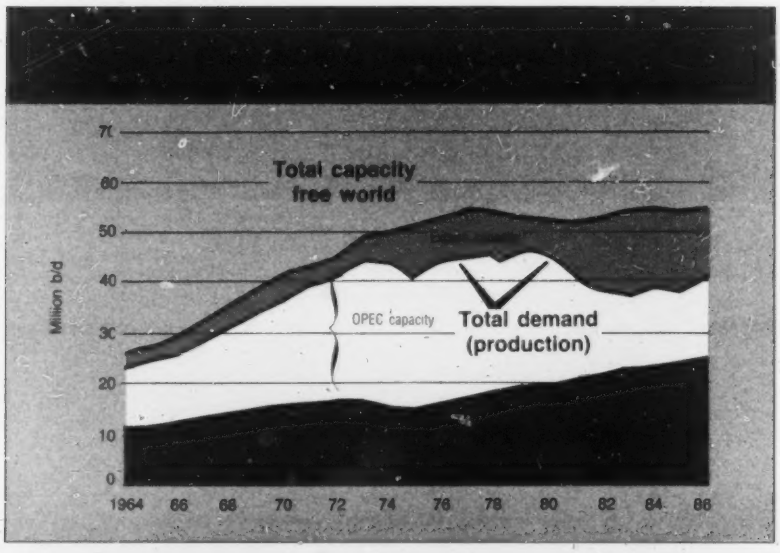

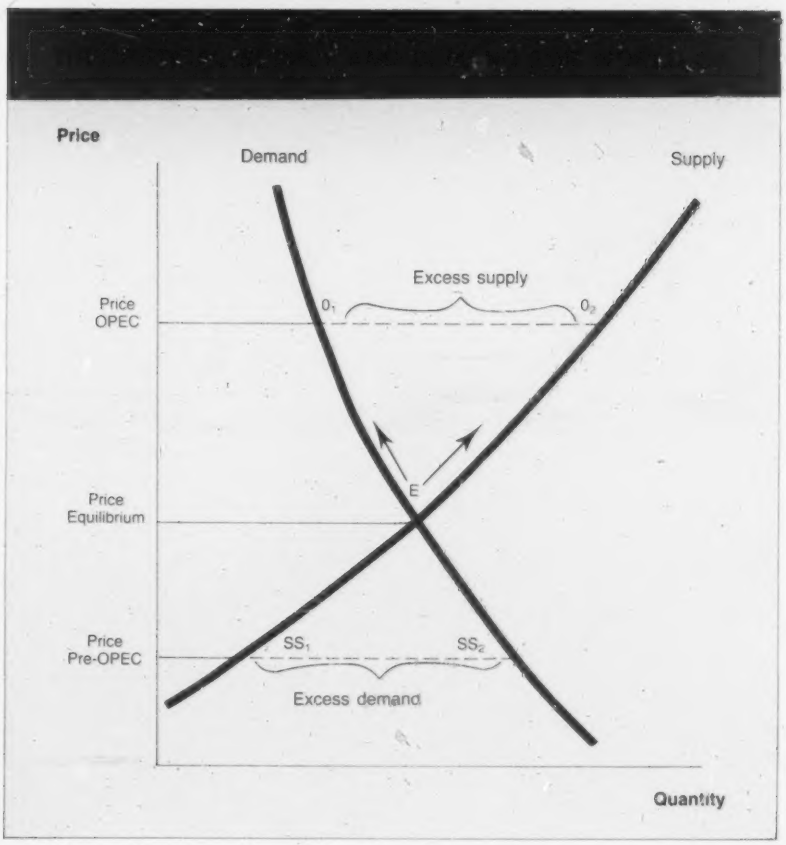

THE STRAIT OF HORMUZ—1986

Country	Crude oil production (1,000 b/d)
Iran	1,848
Kuwait	1,244
Bahrain	44
Saudi Arabia	4,837
Qatar	332
United Arab Emirates	1,325
Total	**9,630**
Free world production	40,454
% of free world production	23.8
Exports via Strait of Hormuz	
Crude	5,500
Products	1,100
Total	**6,600**
Free world crude imports	18,760
% of free world crude imports	29.3%
Free world crude & product imports	25,130
% of free world crude & product imports	26.3%

Source: Author's estimates

source of last resort.

So in the fall of 1985 the Saudis unilaterally arranged, with several selected purchasers, to sell their oil using a new netback pricing arrangement. They were willing to accept a lower price for their oil based on the netback value after product sales and refining, in order to increase their market share. In a subsequent meeting, OPEC policy was changed to one aimed at regaining market share rather than supporting prices. This shift in OPEC policy in effect brought the full weight of the excess crude capacity to bear on worldwide crude oil prices. The result was a collapse in the price of crude oil in early 1986, when winter demand began to slacken.

"The average price of world export crude fell from $27.10/bbl at the end of 1985 to a low of $9.35/bbl the first week of August 1986, a drop of 65%."

The average price of world export crude fell from $27.10/bbl at the end of 1985 to a low of $9.35/bbl the first week of August 1986, a drop of 65%. This did stimulate demand for OPEC oil and did curtail investment, and in some cases production, of competing high cost oil. OPEC did achieve the goal of increased market share. OPEC production moved up to over 21 million b/d in August 1986, 48.1% of total free world output.

PRICING CRUDE OIL. OPEC abandoned their attempt to increase world market share by reestablishing production quotas in late 1986. First they adopted a set of temporary emergency quotas in September 1986, to stop the free fall in crude prices. And then they adopted a more formal set of quotas at the end of 1986 to help sustain a higher price level.

The average price of OPEC export crudes had fallen from $27.81/bbl at year end 1985, to $9.59/bbl in August 1986, during this experiment with increasing market share. When OPEC announced that they were adopting temporary quotas the price moved back up to $12.50/bbl, and remained between $12.30/bbl and $14.70/bbl for the remainder of 1986. Following the adoption of formal quotas in December 1986, the average price of OPEC export crude moved up over $17/bbl. It has been holding at $17.35/bbl to $17.45/bbl for the first half of 1987.

The key to the higher price level has been the adoption of the quotas and the abandonment of netback pricing. Under netback contracts, the price of the crude traded is based upon the value or selling prices of the refined products. The value of the products that can be obtained from the specific type of crude oil are determined by the sales price during a specified time period. Deducted from this value are the costs associated with refining the products and transporting the crude and a specified processing fee or refiner margin. The remainder is the netback value or price of the crude, and represents the amount remitted to the producer. Netback pricing shifts a great deal, if not all, of the price risk in the market to the producer.

Under netback pricing, refiners had a great deal of incentive to try to move large volumes of product by price competition. Under most netback formulas, refiners were virtually guaranteed a profitable margin on each barrel. So the incentive was in increasing the volume sold. The result was increased demand for crude oil but also rapidly declining prices.

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WORLDWIDE OIL REFINING THROUGHPUTS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	% change 86/76	% change 86/79
						(1,000 b/d)							
U.S.	13,435	14,625	14,780	14,465	13,520	12,470	11,775	11,685	12,045	12,005	12,710	−5.4	−12.1
Canada	1,710	1,805	1,820	1,960	2,085	1,945	1,650	1,545	1,570	1,495	1,475	−13.7	−24.7
Latin America	5,670	5,715	5,975	6,220	6,460	6,575	6,080	5,825	5,715	5,285	5,265	−7.1	−15.4
Western Europe	13,180	12,775	12,855	13,665	12,330	10,970	10,075	9,710	9,790	9,490	10,095	−23.4	−26.1
Middle East	2,300	2,240	2,535	2,365	2,445	2,205	2,245	2,515	2,665	2,795	2,950	28.3	24.7
Africa	1,055	1,165	1,280	1,355	1,460	1,525	1,735	1,920	1,975	2,015	2,095	98.6	54.6
Japan	4,230	4,285	4,240	4,340	4,015	3,630	3,360	3,255	3,355	3,120	2,990	−29.3	−31.1
Southeast Asia	1,865	2,030	2,330	2,450	2,370	2,480	2,335	2,380	2,455	2,650	2,730	46.4	11.4
South Asia	550	605	645	675	705	795	840	880	885	1,020	1,110	101.8	64.4
Australasia*	655	680	690	700	640	655	625	605	615	580	570	−13.0	−18.6
Total Non-Communist World	**45,650**	**45,925**	**47,150**	**48,195**	**46,030**	**43,250**	**40,720**	**40,320**	**41,070**	**40,455**	**41,950**	**−6.0**	**−12.9**
Communist	11,575	11,930	12,875	13,230	13,320	13,420	13,575	13,675	13,885	14,165	14,280	23.4	7.9
Total World	**56,225**	**57,855**	**60,025**	**61,425**	**59,350**	**56,670**	**54,295**	**53,995**	**54,955**	**54,620**	**56,270**	**0.1**	**−8.4**

*Includes Australia and New Zealand

Source: British Petroleum

WORLDWIDE OIL REFINING CAPACITIES

Country Area	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	% change 86/76	% change 86/81
						(1,000 b/d)							
NORTH AMERICA													
U.S.	16,400	16,945	17,375	17,920	18,250	18,290	16,860	15,865	15,660	15,460	15,415	−6.0	−15.7
Canada	2,195	2,220	2,340	2,315	2,150	2,155	2,260	2,025	2,015	2,075	2,080	−5.2	−3.5
Total North America	**18,595**	**19,165**	**19,715**	**20,235**	**20,400**	**20,445**	**19,120**	**17,890**	**17,675**	**17,535**	**17,495**	**−5.9**	**−14.4**
LATIN AMERICA													
Argentina	700	660	660	660	690	690	690	690	680	665	670	−4.3	−2.9
Brazil	1,020	1,175	1,230	1,230	1,375	1,530	1,530	1,400	1,305	1,305	1,320	29.4	−13.7
Mexico	970	975	990	1,340	1,475	1,525	1,620	1,630	1,680	1,680	1,680	73.2	10.2
Netherlands Antilles	810	840	840	840	840	780	780	780	740	320	320	−60.5	−59.0
Trinidad	460	465	465	465	455	455	375	375	320	260	300	−34.8	−34.1
Venezuela	1,445	1,445	1,445	1,445	1,425	1,405	1,360	1,225	1,225	1,230	1,230	−14.9	−12.5
Others	2,365	2,480	2,545	2,645	2,580	2,520	2,380	2,205	1,980	1,695	1,715	−27.5	−31.9
Total Latin America	**7,770**	**8,040**	**8,175**	**8,625**	**8,840**	**8,905**	**8,735**	**8,305**	**7,930**	**7,155**	**7,235**	**−6.9**	**−18.8**
WESTERN EUROPE													
Belgium	1,080	1,055	1,030	1,020	1,020	965	720	720	720	720	720	−33.3	−25.4
France	3,495	3,465	3,445	3,420	3,320	3,230	2,745	2,370	2,190	2,175	2,050	−41.3	−36.5
Italy	4,345	4,270	4,205	4,205	4,140	3,990	3,500	3,365	2,745	2,585	2,460	−43.4	−38.3
Netherlands	1,950	1,835	1,815	1,815	1,775	1,775	1,590	1,610	1,380	1,380	1,380	−29.2	−22.3
Spain	1,275	1,210	1,375	1,475	1,425	1,550	1,550	1,440	1,440	1,440	1,440	12.9	−7.1
United Kingdom	2,875	2,655	2,515	2,460	2,460	2,360	2,135	2,105	1,935	1,865	1,850	−35.7	−21.6
West Germany	3,110	3,065	3,090	3,040	3,095	2,955	2,520	2,280	2,115	1,750	1,710	−45.0	−42.1
Others	2,640	2,630	2,880	2,665	2,820	2,830	2,945	2,745	2,705	2,750	2,750	4.2	−2.8
Total Western Europe	**20,770**	**20,185**	**20,355**	**20,100**	**20,055**	**19,655**	**17,705**	**16,635**	**15,285**	**14,665**	**143,360**	**−30.9**	**−26.9**
MIDDLE EAST													
Bahrain	250	250	250	250	250	250	250	250	250	250	250	—	—
Iran	715	965	1,045	1,045	1,225	625	625	600	530	530	530	−25.9	−15.2
Iraq	185	185	230	265	265	265	265	200	300	320	320	73.0	20.8
Kuwait	575	575	575	575	575	530	545	590	590	630	620	7.8	17.0
Saudi Arabia	630	630	635	635	495	660	865	865	865	1,115	1,125	78.6	70.5
Others	595	640	640	770	755	920	1,015	1,055	980	965	1,005	68.9	9.2
Total Middle East	**2,950**	**3,245**	**3,375**	**3,540**	**3,565**	**3,250**	**3,565**	**3,560**	**3,515**	**3,810**	**3,850**	**30.5**	**18.5**
Africa	1,380	1,505	1,730	2,000	2,060	2,035	2,355	2,340	2,540	2,555	2,550	84.8	25.3
ASIA AND AUSTRALASIA													
Japan	5,285	5,285	5,285	5,285	5,675	5,675	5,500	4,975	4,975	4,975	4,975	−5.9	−12.3
Indonesia	525	525	535	535	515	515	515	760	925	925	925	76.2	79.6
Singapore	1,040	1,040	1,040	1,040	1,020	1,020	1,020	1,020	1,020	1,020	960	−7.7	—
Other Southeast Asia	1,270	1,570	1,650	1,810	1,890	1,940	1,940	1,940	2,120	2,005	2,035	60.2	4.9
South Asia	735	785	825	825	870	885	995	1,020	995	1,150	1,150	56.5	29.9
Australasia*	760	760	785	800	810	815	815	815	785	705	740	−2.6	−9.2
Total Asia and Australasia	**9,615**	**9,965**	**10,120**	**10,295**	**10,780**	**10,850**	**10,785**	**10,530**	**10,820**	**10,780**	**10,785**	**12.2**	**−0.6**
Total Non-Communist World	**61,080**	**62,105**	**63,470**	**64,795**	**65,700**	**65,140**	**62,265**	**59,260**	**57,765**	**56,500**	**56,275**	**−7.9**	**−13.6**
COMMUNIST													
China	1,500	1,600	1,800	1,900	1,900	1,810	2,000	2,050	2,150	2,150	2,150	43.3	18.8
U.S.S.R.	9,400	9,600	10,000	10,500	10,700	11,600	11,750	12,000	12,000	12,000	12,000	27.7	3.4
Others	2,480	2,575	2,775	2,825	2,910	3,125	3,170	3,170	3,170	3,170	3,265	31.7	4.5
Total Communist	**13,380**	**13,775**	**14,575**	**15,225**	**15,510**	**16,535**	**16,920**	**17,220**	**17,320**	**17,320**	**17,415**	**30.2**	**5.3**
Total World	**74,460**	**75,880**	**78,045**	**80,020**	**81,210**	**81,675**	**79,185**	**76,480**	**75,085**	**73,820**	**73,690**	**−1.0**	**−9.8**

*Includes Australia and New Zealand

Source: British Petroleum

OPEC appears to be trying to reestablish the old posted price system. But it is doubtful that many purchasers are willing to commit to any long-term contracts in today's volatile market. OPEC export prices have been rather stable for an extended period, but this is mainly due to market conditions rather than an acceptance of posted prices by crude purchasers.

Average non-OPEC export crude prices moved above OPEC prices to stay in March 1987. This is an indication that there is sufficient demand for crude oil to sustain present OPEC prices at the current level of OPEC production. The adherence to production levels close to the adopted quotas has brought supply and demand into close equilibrium and has stabilized prices.

The key to future price stability will be OPEC production discipline and the selection of a quota that can sustain this equilibrium.

However, OPEC found out that there was a tremendous cost for gaining market share at the expense of the price level: August production in 1986 at 21.028 million b/d was up 38.6% over August 1985. And cumulative production for the first eight months of 1986 was up 19.9% from 1985. But prices had fallen 65% and it became obvious that increased volume could not make up for lost revenue from lower prices. If OPEC wanted increased market share, it would be at the cost of substantially lower revenues.

"The policy of trying to gain a greater market share cost OPEC $56 billion in revenue."

The total value of OPEC crude exports had fallen from $282 billion in 1980 to $132 billion in 1985, a drop of 53.4%. Revenues for 1986 were estimated at only $76 billion, down another 42.1%. Estimated revenues for 1986 were down 73% from the 1980 peak.

The policy of trying to gain a greater market share cost OPEC $56 billion in revenue. This was sufficient incentive to reestablish a workable quota agreement. Even though OPEC production is expected to be down from 1986, with the higher average export price, 1987 revenues are estimated to climb back to close to $100 billion.

OPEC may have regained some control over the market and the price of crude oil. But that control is dependent upon their ability to establish a quota that will tighten supply in the market. And it is dependent upon OPEC countries having the long-term discipline to constrain production levels. They have done well during the first half of 1987, but the jury is still out on their ability to maintain long-term production discipline.

SUPPLY VULNERABILITY. This outlook is based upon expectations due to economic forces and doesn't attempt to forecast political events. However, a political upheaval could have some impact on worldwide supply. Of most concern is the closing of the Strait of Hormuz due to action in the Iran-Iraq War. This is of great concern at the present time since war action directed at tanker traffic has increased. And the chances of escalation of the war have increased with the introduction of foreign military vessels in the area. Although it probably also reduces the probability of total closure of the Strait of Hormuz for any extended period.

The potential impact of a closure has been reduced in recent years, along

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with the reduction in dependency upon imports through the Strait of Hormuz. Three years ago, 8.4 million b/d, 36% of free-world imports, were coming through the Strait. At the present time, about 6.4 million b/d is being exported via the Strait of Hormuz. The free-world total imports are somewhere close to 26.3 million b/d. Therefore, 25% of total free-world import requirements would be eliminated if the Strait were closed. Saudi Arabia is increasing the capacity of their pipeline system to the Red Sea. Presently they can move 1.5 million b/d, and this is being increased to 2.9 million b/d. It is estimated that 3 million b/d could be made up by increasing production in other countries with surplus capacity and by diverting more of the Saudi Arabian export stream via the pipeline to the Red Sea.

If the remaining OPEC countries did not increase production sufficiently to cover the 3-4 million b/d shortfall, prices could move up sharply. But the impact on prices would be dependent upon what action was taken to reopen the Strait.

If it appeared that the closing was only temporary, the industrial countries and international oil companies might simply draw down stock levels to meet the demand. Industry stock levels are presently quite low and do not offer much of a buffer against a supply disruption. However, strategic government stocks might be used if there were a temporary disruption.

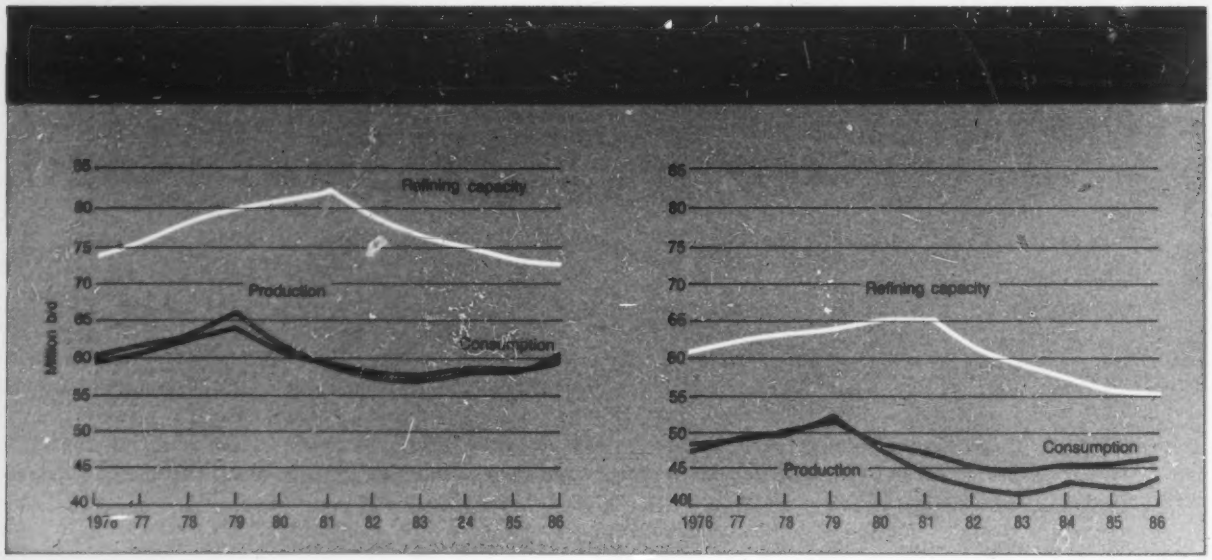
EXPLORATION. The search for oil throughout the non-communist world outside the U.S., has not dropped as sharply as crude oil prices. Obviously all oil importing countries find it financially advantageous to develop their own crude capacity. In addition the international oil companies have found that there is substantially more profit margin in equity crude than in crude purchased from OPEC exporters, so they have continued the search in those areas where they can obtain favorable exploration/development agreements.

"Up until the collapse in prices in 1986, one of the major reasons for the high level of activity in the face of declining demand was the relatively high price of oil."

The number of active drilling rigs outside the U.S. and Canada peaked in 1982 at 1,476. The active rig count fell to 1,288 in 1973, 1,237 in 1984, but went back up to 1,293 in 1985. The rig count did fall 16.2% last year to an average 1,084 in 1986. However this was less than half of the 35-40% drop in average crude oil prices. The 1986 level of activity is down 26.7% from the peak of 1,479 in 1982, but it was still at about the level of 1978 when the count was 1,086.

The highest level of activity outside of the U.S. in 1986 was in Latin America where 371 rigs were active on average. But this was down from 443 in 1985. There was an average of 234 active rigs in the Far East in 1986, down from 261 the year before. There were 184 active rigs in Western Europe, down from 233 and there were 178 active rigs in the Middle East, down from 201.

Up until the collapse in prices in 1986, one of the major reasons for the high level of activity in the face of declining demand was the relatively high price of oil. Since the price of oil far surpassed the general rate of inflation over the past decade, the profit margin increased considerably. Previously, uneconomic or marginal fields were



FREE WORLD ACTIVE RIG COUNT

Region	1978 Total	1979 Total	1980 Total	1981 Total	1982 Total	1983 Land	1983 Off.	1983 Total	1984 Land	1984 Off.	1984 Total	1985 Land	1985 Off.	1985 Total	1986 Land	1986 Off.	1986 Total
	(Annual average)																
Canada	272	339	401	263	200	190	11	201	245	14	259	302	9	311	174	4	178
United States	2,255	2,176	2,910	3,969	3,117	1,972	257	2,229	2,158	271	2,429	1,722	254	1,976	847	123	970
North America	**2,527**	**2,515**	**3,311**	**4,232**	**3,317**	**2,162**	**268**	**2,430**	**2,403**	**285**	**2,688**	**2,024**	**263**	**2,287**	**1,021**	**127**	**1,148**
Argentina	72	63	76	70	67	73	0	73	82	0	82	81	0	81	47	0	47
Brazil	52	60	72	81	94	54	29	83	44	26	70	46	30	76	46	31	77
Mexico	167	205	215	218	202	160	27	187	166	30	196	163	33	196	132	31	163
Venezuela	33	47	52	63	69	29	12	41	21	9	30	23	10	33	16	13	29
Others	58	65	66	89	90	54	13	67	48	13	61	47	10	57	44	11	55
Latin America	**382**	**440**	**481**	**521**	**522**	**370**	**81**	**451**	**361**	**78**	**439**	**360**	**83**	**443**	**285**	**86**	**371**
India	40	40	43	44	50	42	14	56	40	17	57	47	16	63	55	15	70
Indonesia	62	66	77	86	92	62	26	88	56	26	82	56	24	80	42	20	62
Others	79	111	122	125	135	92	39	131	83	36	119	79	39	118	76	26	102
Far East	**181**	**217**	**242**	**255**	**277**	**196**	**79**	**275**	**179**	**79**	**258**	**182**	**79**	**261**	**173**	**61**	**234**
Algeria	101	109	111	91	81	54	0	54	27	0	27	35	0	35	41	0	41
Libya	28	33	41	33	31	23	1	24	24	2	26	28	2	30	20	0	20
Nigeria	16	18	20	23	27	9	8	17	5	6	11	8	2	10	7	3	10
Others	31	41	47	66	70	20	32	52	16	25	41	16	27	43	10	16	26
Africa	**176**	**201**	**219**	**213**	**209**	**106**	**41**	**147**	**72**	**33**	**105**	**87**	**31**	**118**	**78**	**19**	**97**
Germany, Fed. Rep.	22	21	22	26	31	25	0	25	19	0	19	20	0	20	19	0	19
Italy	18	21	19	32	38	19	7	26	20	6	26	31	9	40	24	9	33
United Kingdom	34	34	48	58	58	2	40	42	6	54	60	7	56	63	7	36	43
Others	70	76	90	102	110	61	31	92	65	33	98	69	41	110	56	33	89
Western Europe	**144**	**152**	**179**	**218**	**237**	**107**	**78**	**185**	**110**	**93**	**203**	**127**	**106**	**233**	**106**	**78**	**184**
Abu Dhabi	16	20	23	31	41	12	23	35	9	20	29	9	12	21	8	7	15
Egypt	16	21	26	27	36	16	19	35	15	21	36	16	21	37	17	16	33
Saudi Arabia	22	22	25	29	29	14	12	26	10	6	16	6	5	11	5	1	6
Turkey	17	9	24	26	34	26	0	26	24	0	24	25	0	25	27	0	27
Others	120	72	79	57	60	75	9	84	85	7	92	99	8	107	92	5	97
Middle East	**191**	**144**	**177**	**170**	**200**	**143**	**63**	**206**	**143**	**54**	**197**	**155**	**46**	**201**	**149**	**29**	**178**
Australia	10	11	15	23	32	15	10	25	24	10	34	22	9	31	9	6	15
Others	2	2	3	3	2	3	0	3	2	1	3	5	1	6	4	1	5
South Pacific	**12**	**13**	**18**	**26**	**34**	**18**	**10**	**28**	**26**	**11**	**37**	**27**	**10**	**37**	**13**	**7**	**20**
Total Free World	**3,613**	**3,682**	**4,627**	**5,635**	**4,796**	**3,102**	**620**	**3,722**	**3,294**	**633**	**3,927**	**2,962**	**618**	**3,580**	**1,825**	**407**	**2,232**
Total excl. North America	**1,086**	**1,167**	**1,316**	**1,403**	**1,479**	**940**	**352**	**1,292**	**891**	**348**	**1,239**	**938**	**355**	**1,293**	**804**	**280**	**1,084**

Source: Baker Hughes Inc.

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being developed throughout the world, and huge import bills encouraged countries without sufficient production to stimulate exploration activities.

One major result of this high level of exploration activity has been to prevent a major decline in worldwide crude reserves. In fact, coupled with the decline in demand/production, it has resulted in an increase in reserves over the 1979-1980 level. However, looking to the future as oil becomes more difficult to find, particularly in large quantities, activity must increase in order to maintain reserves. And the level of activity will be sustained and increased only if the price level moves up.

Total worldwide reserves were 697.4 billion barrels as of the first of 1987. Compared to ten years earlier, 1977, reserves were up 57.1 billion barrels, 8.9%. Non-communist reserves at the start of 1987 were 618.2 billion barrels, up 14.6% from 1977. OPEC reserves at the start of 1987 were 478.9 billion barrels, 68.7% of total world and 77.5% of non-communist.

Worldwide reserves have been replaced and even increased throughout the past ten years. This was mainly due to the increased value of oil that stimulated increased exploration activity.

The reserves/production ratio was 35.2 years in 1975. This fell to 26.7 years in 1979, the year of peak production. In 1984, the ratio moved up to 31.7 years. It is estimated at 31.5 years in 1987. The reserves/production ratio has been maintained and there is no apparent immediate pressure on oil availability. However, investment in exploration and production activity will have to be sustained if the reserves-to-production ratio is to be maintained at this level. But it is evident from the reserves profile that OPEC still holds the key position in future world supply. And unless activity is sustained in the non-OPEC areas, the OPEC influence over production and prices will be re-established in the near future. In the long run, OPEC holds the dominant reserve position to dominate the world oil industry.

REFINING. Another key element of the supply side of the equation is refining. The worldwide refining industry has gone through a somewhat similar cycle brought about by the volatile change in prices.

With the drop in demand for petroleum products, crude runs through refineries also fell sharply. As refinery runs fell, excess capacity developed in the refining industry. Refining capacity represents a substantial fixed investment in plant and equipment. Therefore, capacity adjustment to the declining demand was a slow process.

There was an initial delay as refineries attempted to determine if the peaking of demand, and subsequent decline, was a temporary phenomenon, or if it was a permanent demand adjustment that would require adjustment in refining capacity. Based on the long-term forecasts that projected steadily increasing long-term demand, refineries initially adjusted by running at a lower utilization rate. As it became apparent that the downturn in demand was signaling a much lower long-term level of demand, refineries realized that the industry was faced with a massive

excess capacity.

Faced with sharply reduced, and in many cases, negative refining margins, refiners started to adjust capacity by mothballing or permanently closing facilities. Free-world refining capacity peaked in 1980 at 65.7 million b/d and remained relatively high in 1981 at 65.14 million b/d. Capacity had been reduced to 56.275 million b/d in 1986, down 9.425 million b/d, 14.3% from the peak.

"Faced with sharply reduced, and in many cases, negative refining margins, refiners started to adjust capacity by mothballing or permanently closing facilities."

The reduction in demand for petroleum products led to a drop in refinery throughput. And this resulted in a sharp drop in the refinery utilization rate. The refinery utilization rate for free-world refineries fell to 65.4% in 1982 from 74.3% in 1978. A cut in crude refining capacity, and an increase in demand, has boosted the rate up to 74.6% in 1986. Most of the improvement is attributable to the reduction in excess capacity. This improvement in refining utilization has improved refining profitability. But on a worldwide basis it is still felt that there is excess capacity and additional reductions are warranted.

"Now there is another threat to refining profitability emerging, and that is the increase in OPEC refining capacity."

Now there is another threat to refining profitability emerging, and that is the increase in OPEC refining capacity. It appears apparent that some of the OPEC countries intend to carve out a portion of the refined products market. OPEC has plans to increase their refining capacity substantially. Plans are being reviewed, but they had planned to boost capacity to 8.5 million b/d. OPEC will not only be supplying a much greater percentage of their own internal petroleum product requirements, but will also be expanding their role in the product export market. OPEC refining capacity in 1985 moved up to 6.6 million b/d. Excluding Iran where substantial refining capacity was lost in the war with Iraq, OPEC's 1985 capacity was up 28.1% from 1980.

The OPEC capacity in 1984 was 6.4 million b/d. Excluding Iran, whose refining capacity was severly damaged in the war with Iraq, OPEC capacity in 1984 was up 23.2% from 1980.

This may really be one of the major issues of concern to the world oil industry in the future. The major international oil companies have lost control over a substantial portion of world crude production. Now they will be meeting competition from OPEC in refining. This is probably also of concern to the major industrial countries. A great deal of revenue is derived from taxes on refined products. If OPEC is able to capture a portion of the refined product market, they may capture the revenue now collected as taxes by the industrial countries, or substantially drive up the prices of refined products.

A couple of OPEC producers, Kuwait and Venezuela, have made substantial investments in downstream refining and marketing facilities in the industrial countries. They are establishing major fully-integrated operations in these areas, similar to the major international oil companies.

Stock levels play a major role in determining short run and seasonal swings in crude demand and prices. The reluctance of refiners to adjust runs immediately to the initial drop in demand, coupled with a reluctance to break long-term contractual agreements

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OPEC REFINING CAPACITY

Country	1980	(Dec 31) 1982	1985	Change 1985-1980	% change 1985/1980
	(1,000 b/d)				
Algeria	471.2	471.2	471.2	—	—
Ecuador	94.5	94.5	94.6	0.1	0.1
Gabon	44.0	44.0	44.0	—	—
Indonesia	473.4	473.4	837.0	363.6	76.8
Iran	1,320.0	670.0	615.0	-705.0	-53.4
Iraq	305.5	215.5	365.5	60.0	19.6
Kuwait	594.0	594.0	614.0	20.0	3.4
Libya	117.0	117.0	333.0	216.0	184.6
Nigeria	234.0	234.0	234.0	—	—
Qatar	10.5	13.0	63.0	52.5	500.0
Saudi Arabia	878.0	878.0	1,548.0	670.0	76.3
United Arab Emirates	113.5	121.5	162.0	148.5	1,100.0
Venezuela	1,444.9	1,323.1	1,229.2	-215.7	-14.9
Total OPEC	**6,000.5**	**5,249.2**	**6,610.5**	**610.0**	**10.2**

Source: OPEC Statistical Bulletin

WORLDWIDE EXCESS PRODUCTIVE CAPACITY

	Production			Productive capacity*			Excess capacity				
	OPEC	Non-OPEC	Total Non-Comm	OPEC	Non-OPEC	Total Non-Comm	OPEC	Non-OPEC	Total Non-Comm	Total capacity	% of Total production
	(1,000 b/d)										
1960			17,668			19,100			1,432	7.50	8.11
1961	9,364	9,319	18,683	10,150	10,050	20,200	786	731	1,517	7.51	8.12
1962	10,508	9,663	20,171	11,350	10,450	21,800	842	787	1,629	7.47	8.08
1963	11,514	10,036	21,550	12,450	10,850	23,300	936	814	1,750	7.51	8.12
1964	12,964	10,206	23,190	14,050	11,050	25,100	1,066	844	1,910	7.61	8.24
1965	14,339	10,552	24,891	15,500	11,400	26,900	1,161	848	2,009	7.47	8.07
1966	15,770	11,235	27,005	17,050	12,150	29,200	1,280	915	2,195	7.52	8.13
1967	16,850	12,155	29,005	18,200	13,150	31,350	1,350	995	2,345	7.48	8.08
1968	18,786	13,114	31,900	20,300	14,200	34,500	1,514	1,086	2,600	7.54	8.15
1969	20,907	13,569	34,476	22,600	14,650	37,250	1,693	1,081	2,774	7.45	8.05
1970	23,413	14,515	37,928	25,300	15,700	41,000	1,887	1,185	3,072	7.49	8.10
1971	25,326	14,575	39,901	27,400	15,750	43,150	2,074	1,175	3,249	7.53	8.14
1972	27,094	14,845	41,939	29,300	16,050	45,350	2,206	1,205	3,411	7.52	8.13
1973	30,989	14,942	45,931	33,500	16,150	49,650	2,511	1,208	3,719	7.49	8.10
1974	30,729	14,593	45,322	34,800	15,750	50,550	4,071	1,157	5,228	10.34	11.54
1975	27,155	14,418	41,573	36,100	15,600	51,700	8,945	1,182	10,127	19.59	24.36
1976	30,738	14,548	45,286	37,400	15,750	53,150	6,662	1,201	7,863	14.79	17.36
1977	31,278	15,595	46,873	38,700	16,850	55,550	7,422	1,255	8,677	15.62	18.51
1978	29,805	17,304	47,109	36,480	18,700	55,180	6,675	1,396	8,071	14.63	17.13
1979	30,928	17,708	48,636	34,260	19,150	53,410	3,332	1,442	4,774	8.94	9.82
1980	26,890	18,310	45,200	32,730	19,800	52,530	5,846	1,484	7,330	13.95	16.21
1981	22,624	18,853	41,477	31,200	20,400	51,600	8,576	1,547	10,123	19.62	24.41
1982	18,584	19,768	38,352	31,200	21,400	52,600	12,616	1,632	14,248	27.09	37.15
1983	17,317	20,718	38,035	31,200	22,400	53,600	13,883	1,682	15,565	29.04	40.92
1984	17,442	21,922	39,364	31,000	23,700	54,700	13,558	1,778	15,336	28.04	38.96
1985	16,039	22,727	38,766	30,000	24,400	54,400	13,961	1,673	15,634	28.74	40.33
1986	18,057	22,397	40,454	30,000	24,550	54,550	11,943	2,153	14,096	25.84	34.84

*Estimated

WORLDWIDE EXPORT CRUDE OIL PRICES

Official Sales and Term Contract Prices
(Dollars per barrel - 1 January)

Year	Saudi Arabia Arabian Light 34°	Nigeria Bonny Light 37°	United Kingdom Brent 38°	Mexico Isthmus 33°	U.S.S.R. Export Blend 32°
1979	13.34	14.80	15.70	14.10	13.20
1980	26.00	29.97	26.02	32.00	33.20
1981	32.00	40.00	39.25	38.50	39-25
1982	34.00	36.50	36.60	35.00	35.49
1983	34.00	35.50	33.50	32.50	31.20
1984	29.00	30.00	30.00	29.00	28.60
1985	29.00	28.00	28.65	29.00	28.00
1986	28.00	28.65	26.00	26.21	28.15
1987	16.15	17.13	18.25	17.00	18.30
1987-July	17.52	18.92	19.30	18.98	18.40

Source: Energy Information Administration

for crude from export nations, resulted in a huge buildup of stocks in 1980 and 1981. Stocks for the OECD group of countries increased 465 million bbl from 1978 to 1980, and peaked at 3,587 million bbl in 1980.

Refiners originally defended the high stock levels as a buffer against a potential supply disruption and a rebound in demand. But the acceleration in worldwide inflation brought high interest rates that translated into very high carrying costs for the excessive inventories. Refiners found it difficult to reduce stocks in the face of falling demand, but they made a concentrated effort by breaking long-term crude supply agreements and forcing stocks back into the ground by reducing offtakes from the producing countries. From 1980 to 1985, stocks of the OECD countries fell 305 million bbl. Stocks fell 155 million bbl in 1982 alone, contributing almost 500,000 b/d to the supply of crude, and reducing import demand. As a portion of demand was supplied directly from inventory, production and export levels fell at a faster rate than product demand.

It is now felt refiners have reached an acceptable balance between demand and stocks, and that the inventory drawdown has stopped. Any increase in demand will be met by new production rather than a reduction in stocks. With demand expected to move upward throughout the forecast period, stocks will probably increase slightly as a balance is retained, in terms of days of supply. Stocks did move up sharply in the latter half of 1986 as refiners took advantage of extremely low oil prices. But most of these stocks were worked

off during the first quarter of 1987.

NATURAL GAS. Oil is only one of several major energy sources. This must be taken into consideration when analyzing the need for oil.

Over the past 10 years, the level of worldwide oil production has been influenced primarily by the price of oil, but competition from competing fuels has also been a factor. One of the major competing fuels has been natural gas. Worldwide production of natural gas has increased substantially over the past 10 years. Total world production in 1986 was 61.538 trillion cubic feet. This was an increase of 32.9% from 46.3 trillion cubic feet in 1976. Non-communist area production was 34.411 trillion cubic feet in 1986, up 6.0% from 32.474 trillion cubic feet in 1976. The natural gas share of worldwide total primary energy consumption moved up from 18.2% in 1975 to 20.1% in 1985. It fell slightly to 19.9% in 1986. In the non-communist countries, natural gas has lost some of its market share dropping from 19.2% in 1975 to 18.9% in 1985 and 18.1% in 1986. This is primarily due to a drop in U.S. natural gas production and consumption. U.S. production in 1986 was 15,911 billion cubic feet, down 17.3% from 1975.

The communist countries posted the greatest increase over the past ten years, 1976-1986. Production moved up 95.9% to 27.127 trillion cubic feet in 1986. This was an increase of 13.282 trillion cubic feet, primarily due to the increased production of the U.S.S.R..

Production in the U.S.S.R. moved up 113.5% over the same ten-year span, to 24.202 trillion cubic feet in 1986. The U.S.S.R. passed the U.S. in 1983 to become the world's largest producing country. This increase in output enabled the U.S.S.R. to launch the massive level of natural gas exports to Western Europe. The U.S.S.R. also has a policy of transforming segments of their economy from oil-consuming to natural gas. This enables them to export greater volumes of crude oil.

North America was the only geographic area where natural gas production was lower in 1986 than 1976. In North America, production was down 15%. In the other areas production was up. Production was up +206.5% in Africa, +204.8% in Asia and Australia, +51.2% in Latin America, +27.3% in the Middle East and up 6.5% in Western Europe.

As with oil, natural gas reserves are dominated by a few countries and located outside the major non-communist industrial countries. The huge proven gas reserves in the U.S.S.R. have enabled them to boost production. They have 42.7% of total world proven reserves as of January 1, 1987. At their present rate of production, they have 64 years of natural gas available from existing reserves. Iran has the second largest level of reserves at 450 trillion cubic feet, 12.4% of total world reserves. Together these two countries have 55.1% of total world reserves of natural gas.

Including the huge reserves in Iran, total non-communist proven reserves represent a 59-year supply at the 1986 rate of output. This is a huge reserve of energy. If a way can be found for low cost transport to the consuming countries, it could be a major factor in

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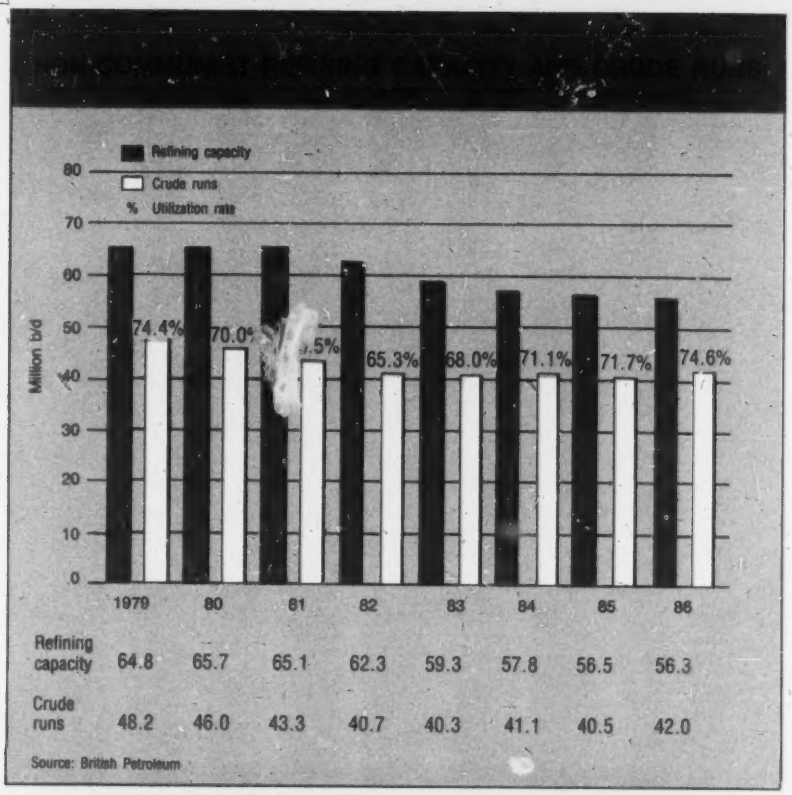
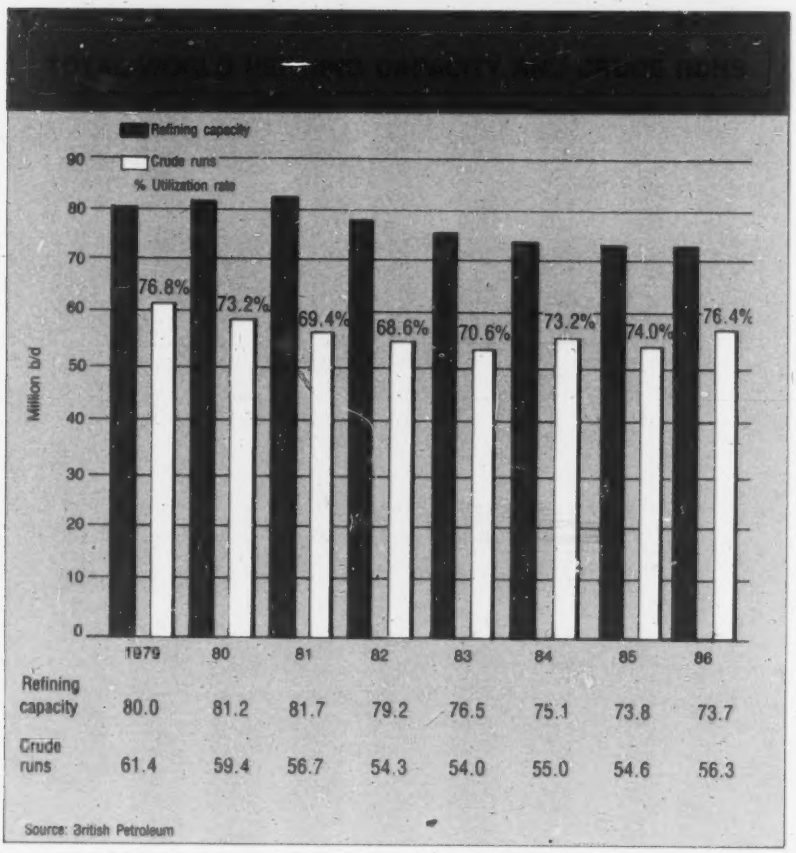

Refining capacity
Crude runs
% Utilization rate
Million b/d
80
70
60
50
40
30
20
10
0
74.4%
70.0%
65.3%
68.0%
71.1%
71.7%
74.6%
1979 80 81 82 83 84 85 86
Refining capacity 64.8 65.7 65.1 62.3 59.3 57.8 56.5 56.3
Crude runs 48.2 46.0 43.3 40.7 40.3 41.1 40.5 42.0
Source: British Petroleum


Refining capacity
Crude runs
% Utilization rate
Million b/d
90
80
70
60
50
40
30
20
10
0
76.8%
73.2%
69.4%
68.6%
70.6%
73.2%
74.0%
76.4%
1979 80 81 82 83 84 85 86
Refining capacity 80.0 81.2 81.7 79.2 76.5 75.1 73.8 73.7
Crude runs 61.4 59.4 56.7 54.3 54.0 55.0 54.6 56.3
Source: British Petroleum

satisfying future energy needs.

In sharp contrast, U.S. reserves represent only 5.1% of the world total and a reserves-to-production ratio of only 11.7 years at the 1986 reduced rate of production.

OUTLOOK

The supply of crude oil available to satisfy demand is closely related to and dependent upon the price level. Price and supply are closely interrelated and dependent upon each other.

The sharp drop in crude oil prices in 1986 altered the outlook for worldwide supply. Both the level of production and the geographic pattern of supply have been altered by the price correction. Even though prices have rebounded in 1987, they have not returned to the pre-1986 levels.

Although production moved up in 1986, there was still substantial excess capacity. Production has slipped slightly in 1987 and this has added to the excess capacity problem. With this continuing large excess capacity, there is substantial downward economic pressure on prices. Upward pressure on prices will only re-emerge when a substantial portion of the excess capacity is eliminated. This would happen due to increased demand and/or a decrease in production; a decrease in production in areas that are producing at or near capacity or in areas where capacity and production are synonymous. This is true mainly in non-OPEC areas.

Without significant upward economic pressure, prices are projected to move up only gradually over the forecast period 1988-1992. As stated in last year's forecast, the average world export price of crude bottomed-out in 1986. It rebounded slightly in 1987 but did not recover to pre-1986 levels. As demand moves up, stimulated by economic growth and lower prices, it will couple with lower non-OPEC production to reduce the excess capacity. Prices are projected to move up gradually over the forecast period but at a rate 2-4% over the rate of inflation. The average price of world export crudes is projected to increase 7.6% to $19/bbl in 1988. The average price will reach $20/bbl in 1989. The average price will continue its rise reaching $24/bbl in 1992, up 36% from the 1987 level.

But just as the present price is supported by OPEC's quota system, future prices over the forecast period will be dependent upon the level of OPEC output. It is expected that after the 1986 experience, OPEC will maintain a quota system that will continue to support prices.

Toward the end of the forecast period, OPEC production will have increased to a level at which there would be a possiblilty for the group to boost prices substantially. At that time the price level will be more dependent upon the objectives of Saudi Arabia. If Saudi Arabia decides to meet the rising demand by increasing output and capacity, they can maintain control over prices. With their substantial reserves it would appear to be in Saudi Arabia's best interests to keep prices from increasing rapidly. It would appear to be in their long-range best interests to keep prices at a level that will stimulate demand and discourage investment in competing oil and energy sources.

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OPEC PRODUCTION QUOTAS

(1,000 b/d)

Country	1983 quota	1983 production	1984* quota	1984 production	1985 production	1986 production
Algeria	725	685	663	608	649	623
Ecuador	200	235	183	258	281	287
Gabon	150	150	137	150	153	159
Indonesia	1,300	1,286	1,189	1,423	1,213	1,231
Iran	2,400	2,467	2,300	2,174	2,257	1,848
Iraq	1,200	893	1,200	1,210	1,435	1,690
Kuwait	1,050	888	900	945	873	1,244
Libya	1,100	1,020	990	1,091	1,052	1,031
Neutral Zone	†	392	†	439	351	343
Nigeria	1,300	1,240	1,300	1,414	1,497	1,465
Qatar	300	295	280	396	299	332
Saudi Arabia	5,000	4,857	4,353	4,464	3,279	4,837
United Arab Emirates	1,100	1,119	950	1,159	1,142	1,325
Venezuela	1,675	1,790	1,555	1,711	1,558	1,642
Total	**17,500**	**17,317**	**16,000**	**17,442**	**16,039**	**18,057**

*Production quotas did not apply for full year. †Quota does not apply to Neutral Zone. Production shared by Kuwait and Saudi Arabia.

Source: OPEC and Author's estimates.

WORLDWIDE GAS RESERVES

Jan. 1 (Billion cu ft)

	1973	1978	1983	1986	1987	Change 1987-1973	% change 1987/1973
Australia	36,236	32,000	17,768	18,220	18,680	-17,556	-48.4
India	2,300	3,500	14,508	16,880	17,550	+15,250	+663.0
Indonesia	5,500	24,000	29,600	35,600	49,440	+43,940	+798.9
Malaysia	*10,000	17,000	34,000	52,700	49,440	+39,440	+394.4
Pakistan	16,000	15,500	18,540	15,400	18,700	+2,700	+16.9
Thailand	—	4,500	11,000	5,400	7,400	+7,400	—
Others	31,200	31,225	20,831	27,297	37,430	+6,230	+20.0
Total Asia-Pacific	**101,236**	**122,725**	**146,247**	**171,497**	**198,640**	**+97,404**	**+96.2**
Netherlands	88,000	60,000	51,920	67,070	70,400	-17,600	-20.0
Norway	15,000	20,000	58,000	104,000	103,188	+88,180	+587.9
United Kingdom	45,000	29,000	25,400	33,000	33,400	-11,600	-25.8
Others	30,400	29,190	21,416	22,337	22,750	-7,650	-25.2
Total Western Europe	**178,400**	**138,190**	**156,736**	**226,407**	**229,738**	**+51,338**	**+28.8**
Abu Dhabi	12,000	20,000	19,260	20,500	90,000	+78,000	+650.0
Iran	200,000	500,000	482,600	470,000	450,000	+250,000	+125.0
Iraq	25,000	28,000	28,800	29,000	28,000	+3,000	+12.0
Kuwait	33,000	31,500	29,900	32,500	35,000	+2,000	+6.1
Qatar	8,000	40,000	62,000	148,000	152,000	+144,000	+1,800.0
Saudi Arabia	50,000	85,000	117,000	121,000	123,990	+73,990	+148.0
Others	16,150	15,160	30,170	34,863	46,310	+30,160	+186.7
Total Middle East	**344,150**	**719,660**	**769,730**	**855,863**	**925,300**	**+581,150**	**+168.9**
Algeria	105,000	125,000	111,250	107,080	106,000	+1,000	+1.0
Libya	27,500	25,700	21,500	21,390	21,180	-6,320	-23.0
Nigeria	40,000	43,000	32,400	47,000	47,000	+7,000	+17.5
Others	16,515	13,804	24,273	22,852	27,260	+10,745	+65.1
Total Africa	**189,015**	**207,504**	**189,423**	**198,322**	**201,440**	**+12,425**	**+6.6**
Argentina	8,800	8,120	25,200	23,588	23,000	+14,200	+161.4
Mexico	11,500	30,000	75,850	76,954	76,500	+65,000	+565.2
Trinidad & Tobago	7,500	8,500	11,000	10,500	10,400	+2,900	+38.7
Venezuela	34,600	41,000	54,079	59,067	59,000	+24,400	+70.5
United States	271,455	210,000	204,000	197,000	185,400	-86,055	-31.7
Canada	55,000	58,000	97,000	99,700	99,600	+44,600	+81.1
Others	16,818	20,960	20,462	19,162	21,170	+4,352	+25.9
Total Western Hemisphere	**405,673**	**376,580**	**487,591**	**485,971**	**475,070**	**+69,397**	**+17.1**
Total Non-Communist	**1,218,474**	**1,564,659**	**1,749,727**	**1,938,060**	**2,030,180**	**+811,706**	**+66.6**
U.S.S.R.	635,400	920,000	1,240,000	1,500,000	1,550,000	+914,600	+143.9
Others	29,000	35,000	43,800	46,000	45,800	+16,800	+57.9
Total Communist	**664,400**	**955,000**	**1,283,800**	**1,546,000**	**1,595,800**	**+931,400**	**+140.2**
Total World	**1,882,874**	**2,519,659**	**3,023,527**	**3,484,060**	**3,625,980**	**+1,743,106**	**+92.6**
Total OPEC	**561,600**	**980,150**	**1,018,564**	**1,116,157**	**1,197,360**	**+635,760**	**+113.2**
OPEC as % of World	29.9%	38.9%	33.7%	32.0%	33.0%	—	—

*Includes Brunei.

Source: Oil & Gas Journal.

Worldwide Supply

The lower level of prices is expected to stimulate demand and therefore production throughout the forecast period 1988 to 1992. Current dollar prices are not expected to get back to the pre-1986 level throughout the forecast period. And although real prices are expected to move up, they will still be substantially lower than the 1979-1985 period.

Total world production is forecast to move up 9.3% over the forecast period, up 5.56 million b/d to 65.05 million b/d. Non-communist production is projected to move up even faster increasing 12.4% over the next five years to 48.95 million b/d in 1992.

This lower level of oil prices will have a negative impact on exploration and development in the higher cost non-OPEC areas. Non-OPEC area production is expected to peak in 1988 as North Sea and Alaskan production both peak. Non-OPEC production is expected to drop slowly over the remainder of the forecast period, falling to 24.7 million b/d in 1992, down 2.1% from 1987.

Increasing demand for crude oil and falling non-OPEC production will result in increased demand for OPEC oil to fill the gap. OPEC production will move up steadily over the forecast period. OPEC production will move up 5.94 million b/d, 32.4%, to 24.25 million b/d in 1992. By 1991 most of the OPEC excess capacity will be eliminated. At that time OPEC will be in a postion to put pressure on prices. By the end of the forecast period, OPEC output will have climbed to 49.5% of non-communist production and 37.3% of total world production.

The exploration effort is expected

VALUE—OPEC CRUDE EXPORTS

Year	OPEC crude exports (1,000 b/d)	Total value (Billion $)	Average price ($/bbl)
1980	24,862.5	282.341	31.028
1981	20,458.1	261.167	35.146
1982	16,466.3	206,205	34.310
1983	14,742.9	161.479	30.009
1984	14,339.7	146.019	27.824
1985	13,350.6	131.513	26.988
Estimated			
1986	14,900.0	76.140	14.000
1987	16,000.0	87.600	15.000
1988	17,000.0	105.485	17.000
1989	18,000.0	111.690	17.000
1990	19,000.0	131.765	19.000
1991	19,500.0	135.233	19.000
1992	20,000.0	146.000	20.000
Total Average	**17,586.2**	**1,982.637**	**23.562**
Total Average 1980-85	17,370.0	1,188.724	30.884
Total Average 1986-92	17,771.4	793.913	17.286

Source: Saudi Arabia's Minister of Petroleum & Mineral Resources

to follow crude oil prices throughout the forecast period. The active international rig count (outside the U.S. and Canada) will bottom out in 1987 at around 975 rigs. As prices move up and demand for oil moves up over the forecast period, the rig count is projected to increase. The rig count is forecast to move up 27.2% to 1240 average rigs in 1992.

"Natural gas resource development is expected to continue to expand over the 1988-1992 period."

Satisfying increasing demand over the forecast period is also dependent upon an adequate level of refining capacity. Total non-communist worldwide refining capacity is expected to move down marginally over the forecast period. Total capacity is expected to slip only 1.4%, 775,000 b/d, to 55 million b/d in 1992. The decline in capacity in the industrial countries will be offset by an increase in OPEC capacity.

In the industrial countries refining capacity is still being adjusted to the lower level of petroleum product demand that was a result of the price shocks. Refining profitability is substantially affected by the utilization rate. Refiners strive for a utilization rate of over 80% in order to achieve adequate margins.

Although capacity will remain relatively constant over the forecast period, crude runs to refineries will move up with demand. Crude runs will increase 8.9% to 46.32 million b/d.

As a result the overall average utilization rate will move up steadily from 76.3% in 1987 to 84.2% in 1992.

There is not expected to be any major geographical shift in natural gas production over the forecast period. The U.S.S.R. is expected to continue to develop their vast reserves, and they are expected to continue to supply European energy needs.

Natural gas resource development is expected to continue to expand over the 1988-1992 period. But the area with the largest reserves, the Middle East, is politically unsettled and a long distance from the larger consuming areas. Therefore, any increase in output is not expected to be major or to have a major impact on world energy needs. However, increased natural gas development for internal consumption in this area would release additional crude for export. That would reduce the upward pressure on prices resulting from increased crude oil demand.

THE OUTLOOK — WORLDWIDE SUPPLY

	1986	1987	1988	1989	1990	1991	1992	Change 1987 to 1992	% change 1987 to 1992
WORLD OIL PRODUCTION (total liquids) (thousand barrels/day)									
OPEC production	19,440	18,310	19,310	20,210	21,470	22,890	24,250	5,940	+32.4
Non-OPEC production	25,130	25,230	25,300	25,150	25,000	24,850	24,700	−530	− 2.1
Total Non-Communist	**44,570**	**43,540**	**44,610**	**45,360**	**46,470**	**47,740**	**48,950**	**5,410**	**+12.4**
Communist	15,620	15,950	16,000	16,050	16,100	16,100	16,100	150	+ 0.9
Total world production	**60,190**	**59,490**	**60,610**	**61,410**	**62,570**	**63,840**	**65,050**	**5,560**	**+ 9.3**
WORLD REFINING (Non-Communist) (thousand barrels/day)									
Capacity	56,275	55,775	55,500	55,300	55,200	55,100	55,000	−775	− 1.4
Crude runs	41,990	42,530	43,330	43,760	44,610	45,500	46,320	3,790	+ 8.9
Utilization rate (%)	74.6	76.3	78.1	79.1	80.8	82.6	84.2	7.9	+10.4
Active drilling rigs (outside U.S. & Canada)	1,079	975	1,030	1,070	1,150	1,190	1,240	265	+27.2
Crude oil price (av. world export price) ($/barrel)	14.98	17.65	19.00	20.00	22.00	23.00	24.00	6.35	+36.0

KEYS TO THE FUTURE

1. Crude oil prices will remain below 1980-1985 levels throughout the forecast period.

2. Lower prices and increased economic activity will boost worldwide demand for crude oil.

3. Worldwide demand for crude oil will move up 9.3% over the forecast period. Non-communist demand will increase 12.4%.

4. Lower prices will dampen increases in non-OPEC production. All the increased demand will be supplied by OPEC whose production will increase 32.4% by 1992.

5. OPEC's excess capacity will be sharply reduced. They will be in a position to boost prices by the end of the forecast period.

6. Increased demand will stimulate increased exploration activity.

7. Refinery utilization rates will improve increasing refining profitability. But there will be a geographical shift in refinery location.

U.S. Outlook

Demand

As anticipated in last year's Outlook the sharp drop in oil prices did have a substantial impact on the demand for petroleum products in the U.S. in 1986. Domestic U.S. consumption of petroleum products posted the largest year-to-year increase since 1977. Demand has exhibited a close relationship to the price level over the past decade. This has dispelled the theory that oil demand was impervious to the price, or in economic terms totally inelastic.

Rising oil demand was stopped in its tracks in 1978 and reversed by rapidly escalating oil prices. And this was after an almost unbroken string of annual increases in consumption dating back to the 1920's. Oil demand does respond to prices, although the price changes have to be major in order to make a significant impact on the level of demand for this major energy source. A great deal more attention will have to be paid to the relationship between oil demand and price in all future analysis.

"Rising oil demand was stopped in its tracks in 1978 and reversed by rapidly escalating oil prices. And this was after an almost unbroken string of annual increases in consumption dating back to the 1920's."

But it isn't only the price of oil that has to be considered in any projection, it is also the cost of competing energy sources. Rising energy costs in the 1970's and early 1980's not only led to conservation but also to fuel switching and multiple fuel capabilities.

As energy costs rose it became apparent to large energy consumers that the most cost effective way to meet their energy needs was through the investment in multiple fuel capacity. With that capability they could easily switch their consumption to the lowest cost fuel available. This has substantially increased the competition between fuels. And as a result, the prices of competing fuels closely track each other.

As competing fuels adjust prices to obtain a competitive advantage or in reaction to shifts in raw material costs, the swings in demand can be substantial. This happened in 1986 with respect to petroleum products. The precipitous drop in prices enabled petroleum to recapture a portion of some fuel markets it had lost in earlier years.

An additional factor affecting demand for petroleum at this lower price level was the reduction in the conservation effort. At lower prices the incentive to invest in conservation capital equipment or fuel switching capital equipment is substantially diminished. In addition much of the conservation was discretionary conservation on the part of the individual consumer. At lower prices the incentive for this personal conservation is greatly eliminated. This is particularly true with respect to driving and gasoline consumption habits and home heating and cooling habits.

All of these factors led to increased consumption of petroleum products when prices plummeted in 1986. As prices moved back up in 1987, petroleum lost some of the competitive advantage but not all. This lower current and real price level is expected to continue to stimulate demand.

The size of the U.S. oil industry in terms of revenue and investment has diminished over the past few years. But it should be remembered that the U.S. economy is still driven to a large extent by the consumption of petroleum and natural gas. These two fuels still provide almost two-thirds of U.S. energy. And their significance will be

only marginally reduced over the forecast period. What happens to the oil and gas industry over the next five years is an important part of what happens to the U.S. economy.

ENERGY DEMAND. The demand for oil, petroleum products and natural gas in the U.S. is closely related and dependent upon the total demand for energy. And the total demand for energy is dependent upon the level and type of economic activity. Therefore, first we will look at expectations, over the forecast period 1988-1992, for economic growth and energy demand.

"Since 1973, the U.S. economy has gone through two recessions. Both followed major increases in oil prices and increases in energy costs in general."

Since 1973, the U.S. economy has gone through two recessions. Both followed major increases in oil prices and increases in energy costs in general. One recession was in 1974-1975 when real Gross National Product (GNP), expressed in 1982 dollars, fell 1.8% over 2 years. The second occurred in 1982, when real GNP fell 2.5%. Between 1978 and 1982, the economy grew only 1.6%; almost at a standstill. The U.S. economy began pulling out of the most recent recession during 1983. Real GNP moved up 3.5% in 1983. The pace of economic growth accelerated in 1984 with real GNP increasing 6.4%. GNP moved up a modest 2.7% in 1985, and only 2.5% in 1986.

The lock-step relationship between economic growth and energy demand in the U.S. was broken in 1970. From 1950 through 1970, real GNP increased 100.2%. Over the same period, energy consumption increased 97.5%. The amount of energy consumed per real dollar of GNP fell only slightly, from 28,200 BTU per dollar of GNP in 1950 to 27,800 BTU in 1970.

From 1970 through 1986, GNP increased 52.1% but energy consumption moved up only 10%. Over that 16-year period, the growth of energy and GNP moved from a one-to-one relationship to a 0.19-to-one relationship, meaning that energy consumption increased only 1.9% for every 10% increase in economic activity. This was a dramatic shift from the previous 20 years.

Total energy consumption per GNP dollar fell for sixteen consecutive years, from 27.8 thousand BTU in 1970 to 20.1 thousand in 1986. Over those sixteen years there was a 27.7% improvement in the efficiency of energy consumed. The rapid increase in the price of energy in the 1970's was a major reason for the improvement in energy efficiency. The rising cost of energy relative to other factors of production provided cost-cutting and profit incentive for minimizing energy requirements.

The oil price hikes of 1973-1974 and 1979-1981 rapidly boosted the cost of petroleum products and the cost of energy in general. This had the effect of providing additional incentive for conservation and accelerated the drop in energy use per dollar of GNP.

Following the 1973-1974 price hike, the economy went into a recession, with real GNP falling in 1974 and 1975. Energy consumption fell from 74,282 trillion BTU in 1973 to 70,546 trillion BTU in 1975, a decline of 5%. Following the 1979-1981 price hike, the economy again went into a recession in 1982. Due to the price-induced conser-

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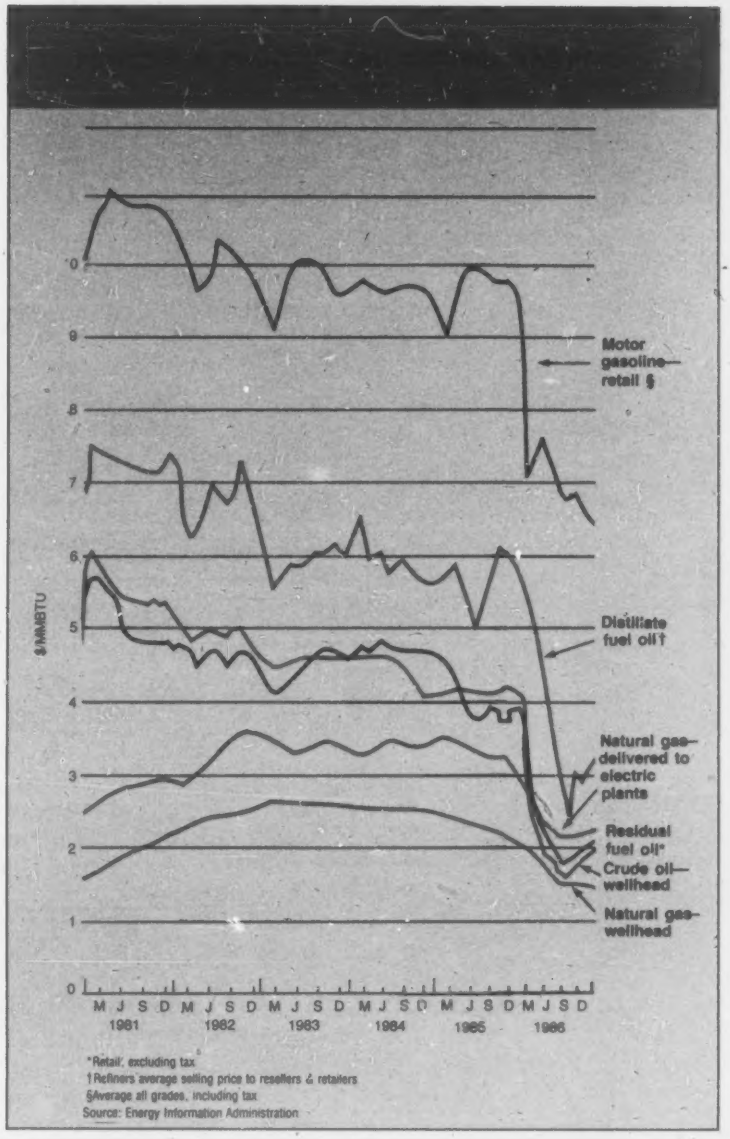
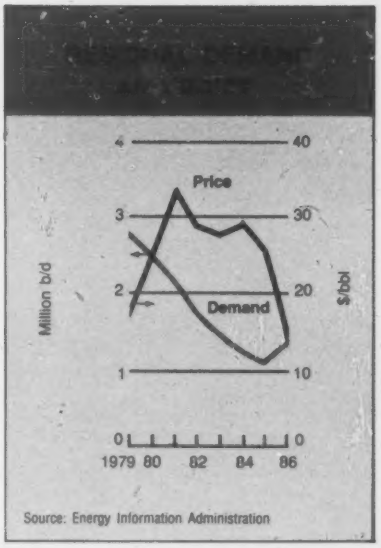


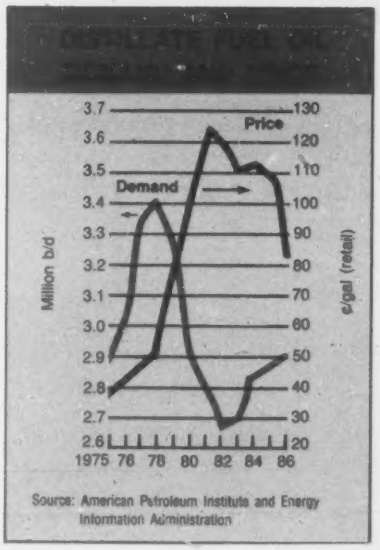
U.S. Demand



PRICES OF FOSSIL FUELS USED IN ELECTRIC GENERATION

	Coal	Residual oil	Natural gas	All fossil fuels	Residual oil price as % of Coal	Residual oil price as % of Natural gas
	(¢/MMBTU)					
1973	40.5	78.5	33.8	47.6	193.8	232.2
1974	70.9	189.0	48.2	91.4	266.6	392.1
1975	81.4	200.5	75.2	104.4	246.3	266.6
1976	84.8	195.2	103.4	111.9	230.2	188.8
1977	94.7	219.8	129.1	129.7	232.1	170.3
1978	111.6	212.5	142.2	141.1	190.4	149.4
1979	122.4	298.8	174.9	163.9	244.1	170.8
1980	135.1	426.7	219.9	192.8	315.8	194.0
1981	153.2	533.4	280.5	225.6	348.2	190.2
1982	164.7	483.2	337.6	224.9	293.4	143.1
1983	165.6	457.8	347.4	220.6	276.4	131.8
1984	166.4	481.2	358.3	219.2	289.2	134.3
1985	164.8	424.4	343.1	209.6	257.5	123.7
1986	157.9	239.3	234.2	174.9	151.6	102.2

*Delivered price to steam-electric utility plants
Source: Energy Information Administration



vation, energy consumption actually started falling in 1980, and the fall accelerated with the drop in economic activity. Energy consumption fell for four consecutive years, dropping 10.7% from 78,898 trillion BTU in 1979 to 70,495 trillion BTU in 1983.

Oil prices have been falling since 1981, and other energy costs have also started to move down. This has moderated the incentive for conservation. During 1984, real GNP increased 6.4% and energy consumption moved up 5.1%. This is a ratio of 0.80 to 1, and is a sharp increase in relative energy consumption. But conservation has not stopped. In 1985, GNP increased 2.7% while energy consumption fell 0.1%. In 1986, GNP increased 2.5% while energy consumption only moved up 0.5%.

"In the U.S. there has been a shift in energy consumption, away from the industrial sector to the residential/commercial and transportation sectors."

Petroleum energy consumed per dollar of GNP has also been falling, particularly since the second oil price hike in 1979. Petroleum energy consumed per dollar of GNP fell from 12.5 thousand BTU in 1977 to 8.6 thousand BTU in 1985. In 1986, it moved up to 8.7 thousand BTU as oil demand increased at a rate higher than GNP.

A substantial part of the more efficient use of energy has been due to price-induced conservation following the rapid and sharp increase in energy costs. But the shift in the profile of the economy has also been an important factor. The U.S. is moving from a principally industrial economy to a more service- and information-oriented economy. These latter types of economic activity are far less energy intensive.

The response to price increases can be spread out over an extended period. It is rapid in the transportation sector, but much slower in the residential/commercial, utility and industrial sectors. In those sectors, adjustment can extend over 10 or more years. A major portion of this demand adjustment is permanent, since it is due to investment in improved capital goods.

In the U.S. there has been a shift in energy consumption, away from the industrial sector to the residential/commercial and transportation sectors. Consumption in the industrial sector has dropped from 31.54 quads in 1973 to 25.74 quads in 1983, a drop of 18.4%. The industrial sector share of total energy consumption dropped from 42.5% to 36.5%. This reflects conservation and more efficient use of energy in the industrial sector, as well as the diminishing importance of the industrial sector in the total economy. However, there was a rebound in energy consumption by the industrial sector in 1984. Energy consumption in this sector moved up 7.7% to 27.72 quads, 37.5% of total energy. One of the major reasons for the surge in energy consumption in 1984 was the economic improvement in the more energy intensive industrial sector.

Industrial consumption of energy slipped a bit in 1985 to 27.01 quads, 36.6% of the total energy consumed. It slipped again in 1986 to 26.11 quads down 3.6%. This was 35.2% of total energy consumed. Expectations are that the relative importance of the industrial sector will continue to slide, but an upturn in economic activity would slow the slide.

Residential/commercial sector energy consumption has increased from

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FACTORS DETERMINING MOTOR GASOLINE DEMAND

	Total vehicle registrations* (1,000)	Total vehicle miles of travel (Billion)	Car registration (1,000)	Average age of cars	Fuel consumed per car (Gallons)	Miles traveled per car	Miles per gallon
1970	108,418	1,120.7	89,244	5.6	735	9,978	13.57
1975	132,962	1,330.1	106,719	6.0	712	9,634	13.53
1980	155,890	1,520.9	121,724	6.6	603	9,135	15.15
1981	158,457	1,556.5	123,462	6.9	579	9,002	15.54
1982	159,510	1,592.5	123,698	7.2	587	9,533	16.25
1983	163,861	1,657.5	126,728	7.4	578	9,654	16.70
1984	166,498	1,716.8	127,867	7.5	553	9,787	17.70
1985	170,237	1,765.2	130,364	7.6	549	9,827	17.90

*Excludes military vehicles.

Source: Motor Vehicle Manufacturers Assoc. Facts & Figures Report 1986, EIA

REFINED PRODUCT PRICES

	Regular motor gasoline pump price (¢/gal)	No. 2 heating oil retail price (¢/gal)	Average landed cost of crude imports ($/bbl)	Refiners' acquisition cost composite ($/bbl)
1976	59.47	41.80	13.34	10.89
1977	63.07	47.37	14.31	11.96
1978	65.71	50.80	14.38	12.46
1979	87.79	72.80	21.65	17.72
1980	121.72	100.97	33.95	28.07
1981	131.10	124.66	36.52	35.24
1982	122.20	120.86	33.18	31.87
1983	115.70	110.12	28.93	28.99
1984	112.90	111.97	28.46	28.63
1985	111.50	107.55	26.66	26.75
1986	85.70	83.45	13.42	14.55

Source: Energy Information Administration

CRUDE OIL PRICES

	Saudi Light (Jan.1)	U.S. average wellhead	Refiners' acquisition cost — Domestic	Imported	Composite
	(Dollars per barrel)				
1970	1.35	3.18	3.46	2.96	3.40
1971	1.75	3.39	3.68	3.17	3.60
1972	1.90	3.39	3.67	3.22	3.58
1973	2.10	3.89	4.17	4.08	4.15
1974	10.84	6.87	7.18	12.52	9.07
1975	10.46	7.67	8.39	13.93	10.38
1976	11.51	8.19	8.84	13.48	10.89
1977	12.09	8.57	9.55	14.53	11.96
1978	12.70	9.00	10.61	14.57	12.46
1979	13.34	12.64	14.27	21.67	17.72
1980	26.00	21.59	24.23	33.89	28.07
1981	32.00	31.77	34.33	37.05	35.24
1982	34.00	28.52	31.22	33.55	31.87
1983	34.00	26.19	28.87	29.30	28.99
1984	29.00	25.88	28.53	28.88	28.63
1985	29.00	24.09	26.66	26.99	26.75
1986	28.00	12.66	14.83	13.98	14.55
Change 1981-1986	-4.00	-19.11	-19.50	-23.07	-20.69
% change 1981-1986	-12.5%	-60.2%	-56.8%	-62.3%	-58.7%
Change 1970-1986	26.65	9.48	11.37	11.02	11.15
% change 1970-1986	1,974.1%	298.1%	328.6%	372.3%	327.9%

Source: Energy Information Administration

REFINED PETROLEUM PRODUCTS SUPPLIED BY TYPE

	Motor gasoline	% of total	Jet fuel	% of total	Distillate fuel oil	% of total	Residual fuel oil	% of total	Ethane and liquefied gases	% of total	Other products	% of total	Total products	% of total	% change from previous year
	(Million b/d)														
1973	6.67	38.5	1.06	6.1	3.09	17.9	2.82	16.3	1.45	8.4	2.22	12.8	17.31	100.0	5.7
1974	6.54	39.3	0.99	5.9	2.95	17.7	2.64	15.8	1.41	8.5	2.12	12.8	16.65	100.0	-3.8
1975	6.67	40.9	1.00	6.1	2.85	17.5	2.46	15.1	1.33	8.1	2.01	12.3	16.32	100.0	-2.0
1976	6.98	40.0	0.99	5.6	3.13	17.9	2.80	16.0	1.40	8.1	2.16	12.4	17.46	100.0	7.0
1977	7.18	38.9	1.04	5.6	3.35	18.2	3.07	16.7	1.42	7.7	2.37	12.9	18.43	100.0	5.6
1978	7.41	39.3	1.06	5.6	3.43	18.2	3.02	16.0	1.41	7.5	2.52	13.4	18.85	100.0	2.3
1979	7.03	38.0	1.08	5.8	3.31	17.9	2.83	15.3	1.59	8.6	2.67	14.4	18.51	100.0	-1.8
1980	6.58	38.6	1.07	6.3	2.87	16.8	2.51	14.7	1.47	8.6	2.56	15.0	17.06	100.0	-7.8
1981	6.59	41.0	1.01	6.3	2.83	17.6	2.09	13.0	1.47	9.1	2.07	13.0	16.06	100.0	-5.9
1982	6.54	42.7	1.01	6.6	2.67	17.5	1.72	11.2	1.50	9.8	1.86	12.2	15.30	100.0	-4.7
1983	6.62	43.5	1.04	6.8	2.69	17.7	1.42	9.3	1.51	9.9	1.95	12.8	15.23	100.0	-0.5
1984	6.69	42.5	1.18	7.5	2.84	18.1	1.37	8.7	1.57	10.0	2.08	13.2	15.73	100.0	3.3
1985	6.83	43.4	1.22	7.8	2.87	18.2	1.20	7.6	1.60	10.2	2.01	12.9	15.73	100.0	—
1986E	7.02	43.5	1.30	8.1	2.90	18.0	1.40	8.7	1.54	9.5	1.98	12.2	16.14	100.0	2.6

E—Estimate.
Source: Energy Information Administration

24.14 quads in 1973 to 27.19 quads in 1986, an increase of 12.6%. This sector's share of the total market increased from 32.5% to 36.7%. The growth in this sector of the economy has more than offset the improvement in energy efficiency and conservation. Growth in this sector is expected to be slow but steady over the forecast period, reflecting the shift to a more service- and information-oriented economy.

"There has not only been a shift in the end use of energy, but also a shift in the source of energy. Over the past 13 years, coal and nuclear energy have been growing in share of the energy market, while petroleum and natural gas have been declining."

Consumption of energy in the transportation sector has also increased over this period, moving up 11.8% from 18.60 quads in 1973 to 20.79 quads in 1986. The share of total energy consumption increased from 25% to 28.1%. Although there has been continued improvement in vehicle fuel efficiency, the total vehicle fleet has been increasing along with the population. And as gasoline and diesel fuel prices have leveled off during the past 2 years, there has been less incentive for discretionary conservation. Energy consumption in this sector was up 8.6% over the past three years.

There has not only been a shift in the end use of energy, but also a shift in the source of energy. Over the past 13 years, coal and nuclear energy have been growing in share of the energy market, while petroleum and natural gas have been declining.

The increase in demand for energy in the form of electrical power has been the primary reason for the increase in coal consumption and nuclear power generation. This is due to the changing nature of the economy. This is also part of the shift to a more service-oriented, information-oriented and automated economy.

Coal energy consumption moved up 34.8% between 1973 and 1985. Coal increased its share of the total energy market from 17.5% to 23.7% in 1985. Coal consumption fell 1.2% in 1986 and coal's market share slipped to 23.4%. A sluggish economy, particularly the industrial sector had an impact. And coal found itself losing market share to cheap residual fuel oil in 1986. That was only a temporary phenomenon, but it did signal the possibility of oil recapturing some of the utility and industrial sector if the price was competitive. Multifuel capability makes fuel switching much easier now than in past years.

Energy from nuclear electric power increased 392%, from 0.91 quads in 1973 to 4.48 quads in 1986. The nuclear share of the energy market increased from 1.2% in 1973 to 6.1% in 1986.

Other forms of energy, primarily hydroelectric and geothermal, provided 5.0% of total energy consumed in 1986. This is up from 4.1% in 1973. Most of this energy comes from hydropower, where the maximum capacity cannot change easily from year to year and output is dependent upon the weather.

Over this 1973 to 1985 period, the petroleum share of the energy market fell from 46.9% to 41.8% in 1985. Energy from petroleum in 1985 was 11.2% lower than 1973, while total energy consumption was down only 0.5%. Lower prices boosted petroleum consumption in 1986 and it increased 3.1%, capturing 43.1% of the energy market.

The natural gas share of the total

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ECONOMIC GROWTH AND ENERGY CONSUMPTION

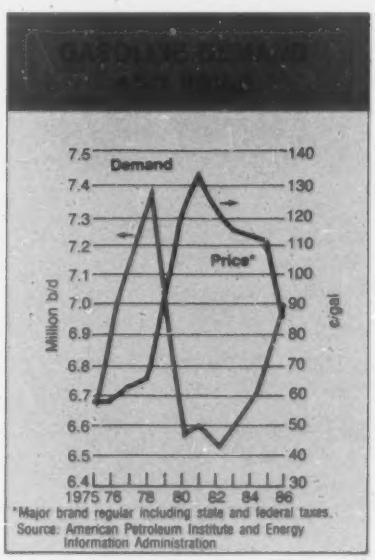
	GNP constant 1982 dollars (Billion)	Total energy consumption (Trillion BTU)	Total energy consumption per GNP dollar (Thousand BTU)	Petroleum energy consumption (Trillion BTU)	Petroleum energy consumption per GNP dollar (Thousand BTU)
1929	711.8	23,756	33.4	5,521	7.8
1933	501.6	16,900	33.7	4,833	9.6
1940	775.0	23,589	30.4	7,407	9.6
1946	1,077.8	30,494	28.3	10,002	9.3
1950	1,206.6	33,992	28.2	13,489	11.2
1955	1,494.9	39,703	26.6	17,524	11.7
1960	1,665.3	44,369	26.8	20,067	12.1
1965	2,087.6	53,343	25.6	23,242	11.1
1970	2,416.2	67,143	27.8	29,537	12.2
1971	2,484.8	68,348	27.5	30,570	12.3
1972	2,608.5	71,643	27.5	32,966	12.6
1973	2,744.1	74,282	27.1	34,840	12.7
1974	2,729.3	72,543	26.6	33,455	12.3
1975	2,695.0	70,546	26.2	32,731	12.1
1976	2,826.7	74,362	26.3	35,175	12.4
1977	2,958.6	76,289	25.8	37,122	12.5
1978	3,115.2	78,088	25.1	37,965	12.2
1979	3,192.4	78,898	24.7	37,123	11.6
1980	3,187.1	75,952	23.8	34,202	10.7
1981	3,248.8	73,989	22.8	31,931	9.8
1982	3,166.0	70,840	22.4	30,232	9.5
1983	3,277.7	70,495	21.5	30,054	9.2
1984	3,489.9	74,064	21.2	31,051	8.9
1985	3,585.2	73,962	20.6	30,922	8.6
1986	3,674.9	73,873	20.1	31,887	8.7
1987E	3,769.1	74,720	19.8	32,035	8.5
Percentage change:					
1929-40	+8.9	-0.7	-9.0	+34.2	+23.1
1940-50	+55.7	+44.1	-7.2	+82.1	+16.7
1950-70	+100.2	+97.5	-1.4	+119.0	+8.9
1970-86	+52.1	+10.0	-27.7	+8.0	-28.7

E - Estimate
Source: Energy Information Administration

U.S. ENERGY CONSUMPTION BY SOURCE

	Petroleum	% of total	Natural gas	% of total	Coal	% of total	Nuclear	% of total	Hydro and other	% of total	Total
	(Quadrillion BTU)										
1973	34.840	46.9	22.512	30.3	12.971	17.5	0.910	1.2	3.049	4.1	74.282
1974	33.455	46.1	21.732	30.0	12.663	17.5	1.272	1.8	3.421	4.6	72.543
1975	32.731	46.4	19.948	28.3	12.663	17.9	1.900	2.7	3.305	4.7	70.545
1976	35.175	47.3	20.345	27.4	13.584	18.3	2.111	2.8	3.147	4.2	74.362
1977	37.122	48.7	19.931	26.1	13.922	18.2	2.702	3.5	2.612	3.5	76.289
1978	37.965	48.6	20.000	25.6	13.765	17.6	3.024	3.9	3.334	4.3	78.089
1979	37.123	47.1	20.666	26.2	15.039	19.1	2.776	3.5	3.293	4.1	78.897
1980	34.202	45.0	20.394	26.8	15.423	20.3	2.739	3.6	3.197	4.3	75.955
1981	31.931	43.2	19.928	26.9	15.908	21.5	3.008	4.1	3.216	4.3	73.991
1982	30.231	42.7	18.505	26.1	15.322	21.6	3.131	4.4	3.647	5.2	70.838
1983	30.054	42.6	17.357	24.6	15.898	22.6	3.203	4.5	3.989	5.7	70.500
1984	31.051	41.9	18.507	25.0	17.074	23.0	3.553	4.8	3.937	5.3	74.064
1985	30.922	41.8	17.851	24.1	17.479	23.7	4.147	5.6	3.572	4.8	73.962
1986	31.887	43.1	16.531	22.4	17.271	23.4	4.475	6.1	3.710	5.0	72.873

Source: Energy Information Administration



*Major brand regular including state and federal taxes.
Source: American Petroleum Institute and Energy Information Administration

energy market has fluctuated more from year to year than petroleum, but it has also moved down since 1973. Natural gas represented 30.3% of the market in 1973 and was down to 22.4% in 1986. Natural gas lost some market share to cheap residual fuel oil in the industrial and utility markets. Natural gas consumption fell to 16.53 quads in 1986, down 26.6% from 1973.

"The most competitive interfuel market is in the industrial and utility sectors where residual fuel oil competes directly with both natural gas and coal."

In 1973, petroleum and natural gas combined accounted for 77.2% of the energy consumed in the U.S.. This was down to 65.5% in 1986—a definite downward trend, but still almost two-thirds of all energy consumed in the U.S.

FUEL COMPETITION. Adjustment to the rising cost of energy not only took the form of conservation but also the form of fuel switching. The transition to a greater capacity for fuel switching took time. It was a reaction to the price shift that was spread out over several years. It required a substantial capital investment in most cases and therefore was dependent upon a more lengthy, complex economic evaluation; an evaluation which included the capital investment cost of alternative fuel facilities.

It is evident from the 1986 energy statistics that substantial multifuel capability is available in the industrial and utility sectors and, to a lesser extent, in the residential sector. This enabled the end users to adjust their energy consumption and choose the lowest cost fuel. In many instances in 1986, this was fuel oil. Although slow to react, natural gas prices and coal prices were forced to adjust to the competition from fuel oil. The net result of the substantial multifuel capacity will be to keep the BTU cost of competing fuels quite competitive.

The most competitive interfuel market is in the industrial and utility sectors where residual fuel oil competes directly with both natural gas and coal. And the demand for residual fuel oil is also affected by the expansion of nuclear fuel capacity for generating electricity.

Another major petroleum product, distillate fuel oil, also competes directly with natural gas for the residential and commercial heating market.

The cost of fuels delivered to steam-electric utility plants gives a good picture of how the relatvive cost of competing fuels has shifted over the past several years. Coal has been, and still is, the cheapest fuel, followed by natural gas, and then resid the most expensive. But the price differentials have changed over time. And for a short period of time in 1986, there was an unprecedented change when for the first time the cost of resid fell below that of natural gas.

In 1973, the cost of heavy oil for steam-electric utility plants was 193.8% of the cost of coal, and heavy oil was 232.2% of the cost of natural gas. These relative prices moved up to heavy oil, 348.2% of coal and 190.2% of natural gas in 1981. Natural gas prices were also moving up rapidly over this period. The utility plant average cost for all fossil fuels increased 373.9% from 1973 to its peak in 1981. Since 1981, heavy fuel costs have been falling. The costs of coal and natural gas slowed their rate of increase from

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REAL PRICE OF GASOLINE

	Regular leaded gasoline price (ct/gal)	Real price* (1967 $)
1918	25.12	55.75
1919	25.47	49.12
1920	29.83	49.70
1921	26.31	49.11
1922	25.20	50.18
1923	21.97	43.02
1924	20.95	40.88
1925	22.20	42.26
1926	23.38	44.14
1927	21.09	40.54
1928	20.94	40.79
1929	21.42	41.73
1930	19.95	39.87
1931	16.98	37.26
1932	17.93	43.81
1933	17.82	45.95
1934	18.85	47.04
1935	18.84	45.84
1936	19.45	46.83
1937	19.99	46.50
1938	19.51	46.21
1939	18.75	45.05
1940	18.41	43.87
1941	19.23	43.60
1942	20.43	41.83
1943	20.53	39.60
1944	20.59	39.06
1945	20.50	38.02
1946	20.77	35.52
1947	23.11	34.55
1948	25.88	35.92
1949	26.79	37.54
1950	26.76	37.14
1951	27.15	34.89
1952	27.56	34.65
1953	28.69	35.80
1954	29.04	36.08
1955	29.07	36.24
1956	29.93	36.76
1957	30.96	36.74
1958	30.38	35.09
1959	30.49	34.94
1960	31.13	35.12
1961	30.76	34.33
1962	30.64	33.81
1963	30.42	33.16
1964	30.35	32.65
1965	31.15	32.96
1966	32.08	32.99
1967	33.16	33.16
1968	33.71	32.35
1969	34.84	31.73
1970	35.69	30.69
1971	36.43	30.03
1972	36.13	28.83
1973	38.82	29.17
1974	52.41	35.48
1975	57.22	35.50
1976	59.47	34.88
1977	63.07	34.75
1978	65.71	33.63
1979	87.79	40.38
1980	119.10	48.26
1981	131.10	48.15
1982	122.20	42.27
1983	115.70	38.77
1984	112.90	36.29
1985	111.50	34.61
1986	85.70	26.10

*Average annual gasoline price deflated by consumer index

EXPORTS OF REFINED PRODUCTS AND CRUDE

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
	1,000 b/d									
Gasoline	2	2	1	1	2	20	10	6	10	33
Distillate	1	3	4	3	5	74	64	51	67	100
Residual	6	13	9	34	118	209	185	190	197	147
Lubricants	26	27	24	23	19	16	16	15	15	23
Coke	102	111	146	137	138	156	195	193	187	238
Asphalt and road oil	1	1	—	1	—	1	1	1	—	1
LPG	18	20	15	21	42	65	73	48	62	42
Other refined products	37	27	39	39	43	38	31	37	39	47
Total refined products	**193**	**204**	**238**	**259**	**367**	**579**	**575**	**541**	**577**	**631**
Crude	50	158	234	287	228	236	164	181	204	154
Total exports	**243**	**362**	**472**	**546**	**595**	**815**	**739**	**722**	**781**	**785**

Source: Energy Information Administration

ENERGY CONSUMPTION—END USER SECTOR

	Residential and commercial	% of total	Industrial	% of total	Transportation	% of total	Total energy consumption
	(Quadrillion BTU)						
1973	24.14	32.5	31.54	42.5	18.60	25.0	74.28
1974	23.72	32.7	30.70	42.3	18.12	25.0	72.54
1975	23.90	33.9	28.41	40.3	18.24	25.8	70.55
1976	25.02	33.6	30.24	40.7	19.10	25.7	74.36
1977	25.39	33.2	31.09	40.8	19.81	26.0	76.29
1978	26.09	33.4	31.41	40.2	20.59	26.4	78.09
1979	25.81	32.8	32.62	41.3	20.47	25.9	78.90
1980	25.65	33.8	30.61	40.3	19.70	25.9	75.96
1981	25.24	34.1	29.25	39.5	19.50	26.4	73.99
1982	25.63	36.2	26.14	36.9	19.07	26.9	70.84
1983	25.62	36.3	25.74	36.5	19.14	27.2	70.50
1984	26.42	35.7	27.77	37.5	19.87	26.8	74.06
1985	26.82	36.3	27.02	36.5	20.12	27.2	73.96
1986	27.24	36.9	25.93	35.1	20.70	28.0	73.87

Source: Energy Information Administration

REFINED PETROLEUM PRODUCTS SUPPLIED TO END-USE SECTORS

	Residential and commercial	% of total	Industrial	% of total	Trans.	% of total	Electric utilities	% of total	Total	% of total
	(Million b/d)									
1973	2.23	12.9	4.49	25.9	9.05	52.3	1.54	8.9	17.31	100.0
1974	2.04	12.3	4.30	25.8	8.83	53.0	1.48	8.9	16.65	100.0
1975	1.95	11.9	4.04	24.8	8.94	54.8	1.39	8.5	16.32	100.0
1976	2.12	12.1	4.45	25.5	9.37	53.7	1.52	8.7	17.46	100.0
1977	2.14	11.6	4.83	26.2	9.75	52.9	1.71	9.3	18.43	100.0
1978	2.07	11.0	4.88	25.9	10.15	53.8	1.75	9.3	18.85	100.0
1979	1.73	9.3	5.35	28.9	9.99	54.0	1.44	7.8	18.51	100.0
1980	1.52	8.9	4.84	28.4	9.55	56.0	1.15	6.7	17.06	100.0
1981	1.33	8.3	4.28	26.7	9.49	59.0	0.96	6.0	16.06	100.0
1982	1.24	8.1	4.06	26.5	9.31	60.9	0.69	4.5	15.30	100.0
1983	1.30	8.5	3.85	25.3	9.40	61.7	0.68	4.5	15.23	100.0
1984	1.34	8.5	4.10	26.1	9.73	61.8	0.56	3.6	15.73	100.0
1985	1.35	8.6	4.01	25.5	9.88	62.8	0.49	3.1	15.73	100.0
1986E	1.35	8.4	3.97	24.6	10.18	63.0	0.64	4.0	16.14	100.0

Source: Energy Information Administration

1981-1984 and fell slightly in 1985. For 1985, the cost of heavy oil for utilities was 257.5% of coal and 123.7% of natural gas. As oil prices plummeted in 1986, the relationship changed rapidly. For the first time, in April 1986, the cost of resid to the utility plants fell below natural gas.

By July 1986, resid prices had fallen 56.6% from the December 1985 price. At that time the resid price was 117.2% of coal and only 85.2% of natural gas.

In the face of this stiff competition from residual fuel oil, both natural gas prices and coal prices fell. Resid prices began to move up again toward the end of 1986, and by November resid had lost its absolute price advantage over natural gas.

The average price of resid delivered to electric utility plants for 1986 was down 43.4%. And for the year, the resid price was 152.1% of coal and 102.4% of natural gas. This was a substantial change in the competitive differentials from those in 1981.

"Domestic demand for petroleum products had increased for 31 consecutive years from 1942 to 1973."

During 1986, the cost of coal to electric utilities fell 4.2% and the cost of natural gas was down 31.7%. The average cost for all fuels fell 16.5%. This is a good example of the intense competition between the fuels. Since the peak in 1981, heavy oil costs were down 55%. Coal costs over the same period are up 3.1% and natural gas costs are down 16.4%. The 1986 price competition from fuel oil brought the cost of these competing fuels much closer together than they had been in years. It is expected that these relative prices will stay quite close over the forecast period.

There are a couple of other factors which may also have an impact on this fuel competition. With repeal of the Fuel Use Act, the limitation on the use of natural gas by heavy industry and utilities is eliminated. And environmental concerns over coal use may make it a more costly fuel if substantial investment is required for environmental reasons. This could make both residual fuel oil and natural gas more competitive in that market.

PETROLEUM PRODUCT DEMAND. Total energy demand did not increase significantly in 1986, but demand for petroleum products jumped up 555,000 b/d, 3.5%. It was the largest year-to-year increase in petroleum product demand since 1977.

Prior to the sharp price hike in the 1979-1981 period, it was felt that petroleum demand was not related to or affected by the price level. But at that time it was not imagined that the price of crude oil could take such gigantic swings. In fact, the sharp drop in oil prices in 1986 took the vast majority of analysts by surprise.

When prices moved up sharply in 1979-1981, petroleum demand reacted and began to fall. Petroleum demand in the U.S. peaked in 1978 prior to the second price shock and then fell for five consecutive years. This decline was unprecedented in duration.

Domestic demand for petroleum products had increased for 31 consecutive years from 1942 to 1973. The only downturn of any duration has been during the Great Depression, when demand fell for three consecutive years between 1929 and 1932.

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U.S. Demand

Following the price rise in 1973-1974, demand for petroleum products fell 5.7% from 17.308 million b/d to 1973 to 16.322 million b/d in 1975. When prices then leveled, demand resumed its increase, rising for three more years to peak at 18.847 million b/d in 1978. Over that three-year period, 1975-1978, demand increased 2.525 b/d, 15.5%.

The second price hike put an end to the steady rise in demand for petroleum products. It had an almost immediate impact on demand. Demand fell 3.616 million b/d over the next five years to 15.231 million b/d in 1983. This was a drop of 19.2% and put demand back at the 1971 level—12 years earlier. Price-induced conservation was the major reason for the decline, but sluggish economic activity also contributed to the drop in petroleum demand.

Demand for petroleum products increased in 1984 after the five consecutive years of decline. Lower prices for petroleum products and substantial economic growth helped boost demand 3.2% in 1984 to 15.726 million b/d. Demand remained at this level in 1985 as economic growth slowed. The substantial drop in prices stimulated petroleum product demand in 1986 and it jumped up another 3.5% to 16.281 million b/d. This is the highest level of demand since 1980.

In the U.S. economy, demand for petroleum products is down from the 1978 peak in all sectors of the economy. However, demand in the residential/commercial sector and transportation sector has been rising since 1982.

The sharpest decline has been in consumption by electric utilities. Since 1978, electric utilities have moved away from oil to coal and nuclear. Demand dropped from 1.75 million b/d to 425,000 b/d in 1985, down 72.7%. The share of total petroleum demand has fallen from 9.3% to only 3.0%. Competition from nuclear power, coal and natural gas have all reduced demand in this sector. For the first time since 1978, consumption of petroleum products by electric utilities moved up. Because of the lower price, consumption jumped up 32.9% to 631,000 b/d. This represented 3.9% of total petroleum product consumption.

Industrial sector demand peaked in 1979 at about 5.3 million b/d. It fell to an estimated 4.03 million b/d in 1985, down 24.7%. The industrial sector share of total domestic demand has not changed a great amount. It was 25.9% in 1973, moved up to 28.9% in 1979 and was 25.7% in 1985. Industrial sector consumption also moved up in 1986, increasing 2.6%. But the share dropped to approximately 24.6% in 1986.

Residential and commercial sector demand was trending down from 1973 to 1982, dropping 44.4% from 2.23 million b/d to 1.24 million b/d in 1982. This sector's share of the total fell from 12.9% to 8.1%. Conversion to natural gas and the use of natural gas for new buildings, because of the price advantage, was the main reason for the downward shift. Demand in this sector has been on the rise over the past three years, moving up to 1.35 million b/d in 1985, 8.6% of total demand. Estimated demand in 1986 was at about the same

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level as 1985. The share of total petroleum demand fell to 8.4%.

Transportation sector demand in 1985 was still below the 1978 peak. But sector demand had been on the rise since 1982, and the share of total demand has been constantly increasing since 1977.

Transportation demand hit 10.15 million b/d in 1978, but then fell 8.3% to 9.31 million b/d in 1982. The reasons for the decline were improved efficiency of motor vehicles, and cost consciousness and conservation by drivers.

Demand moved back up 5.6% to 9.83 million b/d in 1985. The transportation sector's share of total petroleum demand has moved up from 52.9% in 1977 to 62.8% in 1985. Petroleum products do not have major fuels competition in the transportation sector. Stimulated by the low gasoline prices, transportation demand moved up an estimated 3.5% in 1986. The share of total demand moved up also to 63.0%.

"Since 1981, the price of crude has been falling. The composite U.S. refiner acquisition cost for 1984 was $28.63/bbl."

One of the things that was underestimated or ignored in some past outlooks was the price elasticity of demand for petroleum products. That is, the change in demand relative to a change in price.

There is no way to isolate demand for petroleum products and measure only the response due to price change, but the sharp price hikes, particularly in the late 1970s, enable the calculation of a rough estimate. Over the past few years, the elasticity of demand for all petroleum products has been approximately 0.1. For every 10% increase in the price, demand fell 1%. This varied from product to product.

Although this would indicate that demand was relatively "inelastic," it does show that, contrary to some preconceived notions, demand would fall if the price increase was too great.

From 1970 to 1981, the composite U.S. refiner acquisition cost of crude oil increased 936%, from $3.40/bbl to $35.24/bbl. This is an increase of $31.74/bbl and an annual average relative increase of 23%/year. Crude oil prices obviously determine product prices, which also skyrocketed. These massive price increases, far surpassing the overall rate of inflation, had a tremendous impact on investment and consumption decisions and resulted in a reduction in demand for oil products.

Since 1981, the price of crude has been falling. The composite U.S. refiner acquisition cost for 1984 was $28.63/bbl. This was a drop of 18.8% from the 1981 average price. Demand rebounded in 1984, increasing 3.2%. This is a roughly 1.7% increase in demand for every 10% decrease in price. There are obviously many factors affecting demand, but relative price is one. However, it will take a longer period to determine if demand elasticity is close to this estimate.

In 1985, the refiner acquisition cost fell an additional 6.5%, but demand remained at the same level as 1984. This would indicate an even lower elasticity of demand, closer to 1% change for every 10% shift in price, since 1981. In 1986, the refiner composite acquisition cost of crude oil fell another 45.6% to $14.55/bbl. In response demand moved up 3.5%.

Since peaking in 1981, the cost of crude has fallen 58.7% to the refiner.

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"The impact of price on motor gasoline demand has not been as great as some other petroleum products, but it has been significant."

Since hitting a low in 1983, demand has increased 6.9%. Although there was a delayed response, this indicates approximately a 1.17% increase in demand for every 10% drop in price. These are very rough measures but they do indicate a low price elasticity that should be taken into account when projecting demand.

The impact of price on motor gasoline demand has not been as great as some other petroleum products, but it has been significant. Demand peaked in 1978 at 7.412 million b/d and then fell 11.8% to 6.539 million b/d in 1982. The price of gasoline obviously influenced driving behavior, reducing the number of miles driven and changing attitudes about type of vehicles. Drivers cut out a lot of wasteful discretionary driving and also opted to purchase more fuel-efficient vehicles. Gasoline demand fell about 1% for every 10% increase in price. The major impact of the rapid increase in price was the federal government-mandated vehicle fuel efficiency standards. This forced improvement in vehicle fuel-efficiency.

As prices have been on the decline in the last few years, motor gasoline demand has increased. The average pump price for motor gasoline fell below $1/gal for the first time since 1979, declining to 93.1cts/gal in 1986. And motor gasoline demand moved up 3% to the highest level since 1979 at 7.034 million b/d. This was only the fourth year on record where gasoline demand exceeded 7 million b/d.

When adjusted for inflation, the average price of motor gasoline was the lowest ever recorded. With the real price at or near historical lows, individual discretionary conservation diminishes substantially.

Motor gasoline demand of 7.034 million b/d in 1986 was up 7.6% since the recent low in 1982. The average pump price for all types of motor gasoline was down 31.2% from the peak of $1.353/gal in 1981. That would represent a 2.4% increase in demand for each 10% decline in price.

The level of demand for motor gasoline is affected by a number of competing factors: vehicle fuel efficiency, average miles driven per vehicle, and total number of vehicles in the fleet. The total number of vehicles registered has been steadily rising. It had reached 170 million in 1985, up 7.4% from 1981 the year of peak gasoline prices. Car registrations were 130.3 million, up 5.6%. Miles traveled per car in 1985 were 9827 up 9.2% from the 9002 in 1981. Miles driven per car were at an all time high of 10,184 in 1972.

These factors are offset by the improved vehicle efficiency and declining fuel consumption per vehicle. The average miles driven per gallon of gas consumed were 17.9 in 1985. This is up 15.2% since 1981, and up 36.6% from the low of 13.1 miles per gallon in 1973.

Highway and rail transport; and residential and commercial heating are the major uses for distillate. Demand for distillate fuel oil also peaked in 1978, at 3.432 million b/d. It then fell sharply, 22.2%, to 2.671 million b/d in 1982. Between 1978 and 1981, the price of home heating oil increased 165.1% from 38.7cts/gal to $1.026/gal. This resulted in a sharp shift to natural

gas for heating and a sharp cut in fuel oil used. During the decline, distillate demand fell about 1.25% for every 10% increase in price. Distillate prices have also been falling since 1981. As a result, distillate demand has been moving up since 1982. Demand has moved up 9.1% over the past four years. Distillate demand moved up 1.6% in 1986 as prices fell.

"The shift by electric utilities from residual fuel oil to cheaper fuel sources such as coal, nuclear and hydro, was the major reason for the drop in resid demand."

Highway diesel demand is closely related to the level of economic activity. It has been increasing as the economy has expanded. This trend is expected to continue with diesel consumption moving up along with economic activity.

This increase in distillate demand has been partially offset by a decline in demand for home heating oil. Home heating oil has been losing share in the residential and commercial heating market to natural gas. As oil prices have declined, conversions to natural gas have slowed but natural gas is still gaining market share. Natural gas or electric home heating are capturing a major share of new construction.

Changes in demand for residual fuel oil have accounted for a large share of the change in total petroleum product demand. Total demand in 1985 was 15.726 million b/d, down 3.121 million b/d from the peak 1978 level. Residual fuel oil demand in 1985 was 1.202 million b/d down 1.821 million b/d from the 1978 level. The drop in resid consumption was 58.3% of the decline in total petroleum consumption. Resid demand in 1985 was down 60.9% from the peak in 1977 of 3.071 million b/d.

The shift by electric utilities from residual fuel oil to cheaper fuel sources such as coal, nuclear and hydro, was the major reason for the drop in resid demand. In 1978, almost half of the resid consumed was by the utility sector; 48.3% or 1,461 million b/d. By 1985, utility sector demand had fallen 71% to an estimated 424,000 b/d. Industrial demand was also down sharply, falling from 622,000 b/d in 1978 to an estimated 182,000 b/d in 1985. The resid demand response to the price increases was much greater than for some other products. With more competition from competing fuels, resid demand tends to be more "elastic." Resid demand fell about 3% for every 10% increase in price.

Last year resid demand jumped up 18%, an increase of 216,000 b/d. The much lower crude and resid prices enabled resid to recapture a portion of the industrial and utility demand for heavy fuel oil. The increase in resid demand accounted for 36.4% of the total increase in demand in 1986.

The long-range demand for resid will depend upon its competitive price compared to natural gas and coal. Projecting beyond the forecast period, the fuel source for growing electrical power demand is in doubt. There is little if any additional nuclear power capacity planned beyond the 1990's. Environmental concerns over acid rain are growing and this may put some temporary economic limitations on the growth of coal consumption. This may open up an opportunity for renewed demand for heavy fuel oil.

Other petroleum products demand has also been moving up over the past few years. Demand for jet fuel has

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moved up rapidly over the period 1982-1986. Total demand for jet fuel has increased 25.9% to 1.307 million b/d in 1986. The increase has been in demand for kerosine jet fuel for commercial aircraft. Deregulation in the airline industry has led to keen competition along with fare slashing. This was assisted by lower fuel cost. The result was a substantial increase in passenger traffic and a jump in jet fuel demand. This trend is expected to continue along with the growth in the economy.

Demand for all other products also moved up faster than total demand. This group includes petrochemical feedstocks, lubricants, still gas, waxes, asphalt, coke and others. Demand increased 12.4% over the period 1982-1986. Demand is expected to continue to move up. It will be driven by petrochemical demand and asphalt demand. Asphalt demand is expected to be high for some time due to the needs to repair and resurface the state and interstate highways.

"Lower energy costs, lower interest rates and increased productivity could combine to give the economy a very vigorous boost, but this is dependent upon a resolution of the hefty debt problem."

OUTLOOK

The demand outlook has not changed dramatically over the outlook prepared a year ago. At that time it was stated that, "the combination of lower oil prices, lower petroleum product prices and increased economic activity will give a boost to U.S. petroleum demand over the forecast period." That same statement could be applied to this outlook.

However, demand is very dependent upon the level of economic activity and will tend to follow the pattern of economics growth or decline. Lower oil and energy costs should help boost the rate of economic growth, but it is not the only factor determining economic growth.

The rate of economic growth will not be spectacular over the forecast period, with the economy expanding at an average annual rate of about 2.6% - 2.7%. The economy will not be expanding at a level close to its potential, but it is not expected to slide into a recession during this period. Lower energy costs and lower interest rates should boost investment and productivity, but potential growth will be moderate due to the overhanging burden of huge government, corporate and personal consumer debt. The economic growth rate will probably be slowed during the forecast period as attention is diverted from productive activity to debt management. It is expected that the economy will slow to a crawl and be in danger of recession at some point over this five-year period. It is expected that this will happen during the first 2 years of the forecast period.

The lower energy costs should help to prevent a recession during the forecast period, but the business cycle is not completely dead. Expectations are that the rate of growth will slow in 1988 and 1989 due to the heavy burden of government, corporate and personal debt. Economic growth will slow to about 1.5% in 1989. If the debt problem can be dealt with effectively, then the economy should rebound and economic growth will pick up toward the end of the forecast period. GNP will be moving up at an annual rate of 3-4% over the 1990-1992 period.

Lower energy costs, lower interest

rates and increased productivity could combine to give the economy a very vigorous boost, but this is dependent upon a resolution of the hefty debt problem. Real GNP is forecast to be up 14-16% by 1992.

Because of the much lower cost of energy, it is expected that energy consumption will move up at a faster rate relative to GNP than in recent years. Total energy is expected to increase at an average annual rate of about 1.5%, more than half the growth rate of GNP.

Energy efficiency improvements would continue, but they will be more than offset by the increase in energy consumption to support economic growth. With much lower-cost energy, there will be less conservation and more energy consumption than with higher prices.

The trend in the relationship of energy to real GNP will continue down the path of increased energy efficiency. Energy required per dollar of real GNP will drop to 18,680 BTU by 1992, a further 5.7% improvement in energy efficiency.

Total energy demand will increase 7.6% over the forecast period. Energy from petroleum is expected to increase at a slower rate than overall energy, moving up 7.1%. Lower prices will make petroleum very competitive with other energy sources.

Energy from nuclear power is expected to increase 26.8% over the period. This is growth from new plants already under construction and increased output from existing facilities. Nuclear will have 7.6% of total energy by 1992. There will be little growth in nuclear energy beyond the forecast period.

Energy from coal will continue to move up slowly over the five-year period. Increased competition from petroleum will slow growth in coal. But the market share will increase to 23.6% in 1992. Coal took over as the second leading fuel source in 1986 and will retain this postion. The petroleum share of the energy market will slip marginally over the forecast period falling from 42.9% in 1987 to 42.7% in 1992. The lower price level will enable petroleum to compete more effectively in the energy market.

Natural gas is expected to lose market share falling from 23.3% in 1987 to 21.5% in 1989 and 21.3% in 1992. To a great extent, natural gas has taken over petroleum's role as the swing energy source. This may change with repeal of the Fuel Use Act and more inovative and aggressive gas marketing.

Petroleum and natural gas in combination will account for 63.9% of total energy needs in 1992. This will be down only slightly from 65.2% in 1987. It is obvious that these energy sources will be extremely important to the U.S. economy for the forseeable future.

The energy market is expected to become more competitive over the forecast period. It is also expected that the price/cost of competing fuels will continue to converge over the 1988-1992 period and will remain very close together.

Petroleum energy demand is made up of demand for a variety of individual petroleum products. Demand

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for each of these products is affected differently by the price level, the level of economic activity and the intensity of competition from other energy.

In general, the combination of lower oil prices and continued economic growth will stimulate total demand for petroleum products over the forecast period. Total domestic demand will increase 7.1% over the forecast period moving up to 17.53 million b/d. This will be a volume increase of 1.16 million b/d. This would be the highest level of demand since the 1977-1979 period when annual demand was over 18 million b/d.

"In general, the combination of lower oil prices and continued economic growth will stimulate total demand for petroleum products over the forecast period."

Motor gasoline demand will move up over the forecast period, but not as rapidly as overall demand. Demand for gasoline will increase 2.7% to 7.28 million b/d in 1992.

The total vehicle fleet is expected to increase as well as the miles driven annually per vehicle, but this will be offset by the improvement in vehicle fuel efficiency. Gasoline prices will move up over the forecast period, increasing about 30.5%, but increased economic activity will give the driving segment of the population more discretionary income to spend on travel. The real price of gasoline adjusted for inflation is expected to increase only about 13% over the five-year forecast period. The real price is expected to be at a level comparable to the early 1970's. Therefore, there is not expected to be a great deal of reason for motorists to exercise a lot of discretionary conservation.

Demand for jet fuel is expected to continue to climb throughout the forecast period. Although competition in the airline industry may slacken in intensity over the forecast period, it is expected that demand will be spurred by increased economic activity and relatively low air fares. Demand will increase approximately 12.4% to 1.54 million b/d. Increased economic activity will create additional demand for air service. Relatively low fuel costs will enable airlines to continue to engage in fare competition. The result will be increased demand for jet fuel.

Distillate demand is also expected to move up over the forecast period, stimulated by increased economic activity. A large percentage of distillate demand is for diesel fuel for transport and this is directly related to overall economic activity. However, this will be offset by declining distillate demand for residential and commercial heating. Demand in the heating sector is losing market share to natural gas and more efficient electrical heating systems. Total distillate demand is projected to increase 10.9% over the forecast period to 3.26 million b/d in 1992.

The level of demand for residual fuel oil is the key to the level of future total demand for petroleum products. The sharp drop in prices in 1986 led to a sharp increase in resid demand. This gave economic evidence of the price level at which resid can compete with natural gas and coal for the industrial and electric utility markets.

Resid prices have moved back up in 1987, but have not returned to the pre-1986 levels. Therefore, resid is expected to lose a large portion of the market share it gained in 1986. However, the generally lower price level that existed over the 1979-1985

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period should slow the decline in resid demand.

With little, if any, planned expansion of nuclear facilities beyond 1990 and with environmental concerns about expanding coal consumption, a gap will develop for fuel for power generation. Resid is expected to fill a portion of that gap starting in 1990. Therefore, over the entire forecast period, resid demand is expected to increase 190,000 b/d, 14.8%, to 1.47 million b/d in 1992.

With a lower price level for petroleum products in general, demand for all of the other diverse petroleum products is also expected to move up along with economic activity. Ethane and LPG demand is projected to increase 7% and other product demand is projected to increase 8.5% by 1992.

One factor that is holding back a major resurgence in oil demand is the long-range price expectations. Since increased demand of any significant amount must be met by OPEC production, potential customers are reluctant to commit to capital equipment that requires oil consumption. OPEC is not noted for exhibiting price restraint when the market conditions are in their favor. Even though market conditions may be different now than in the 1970's, the return to oil as a fuel source will be cautious over the forecast period.

"One factor that is holding back a major resurgence in oil demand is the long-range price expectations."

THE OUTLOOK — U.S. DEMAND

	1986	1987	1988	1989	1990	1991	1992	Change 1987 to 1992	% change 1987 to 1992
ENERGY DEMAND (trillion BTU)									
Petroleum	31,887	32,035	32,310	32,520	33,155	33,790	34,295	2,260	+ 7.1
Natural gas	16,531	16,690	16,585	16,330	16,765	16,940	17,120	430	+ 2.6
Coal	17,271	17,385	17,600	17,865	18,135	18,640	18,985	1,600	+ 9.2
Nuclear	4,475	4,810	5,145	5,455	5,730	5,970	6,100	1,290	+26.8
Hydro and other	3,709	3,800	3,830	3,860	3,890	3,900	3,900	100	+ 2.6
Total	**73,873**	**74,720**	**75,470**	**76,030**	**77,675**	**79,240**	**80,400**	**5,680**	**+ 7.6**
PETROLEUM DEMAND (thousand barrels/day)									
Motor gasoline	7,034	7,090	7,120	7,150	7,200	7,240	7,280	190	+ 2.7
Jet fuel	1,307	1,370	1,425	1,440	1,490	1,510	1,540	170	+12.4
Distillate fuel oil	2,914	2,940	2,995	3,040	3,120	3,190	3,260	320	+10.9
Residual fuel oil	1,418	1,280	1,250	1,250	1,320	1,400	1,470	190	+14.8
Ethane and LPG	1,512	1,580	1,600	1,610	1,640	1,680	1,690	110	+ 7.0
Other products	2,096	2,110	2,130	2,150	2,200	2,250	2,290	180	+ 8.5
Total	**16,281**	**16,370**	**16,520**	**16,640**	**16,970**	**17,270**	**17,530**	**1,160**	**+ 7.1**
CRUDE OIL PRICE ($/barrel)									
U.S. average wellhead	12.66	14.85	16.25	17.50	19.25	21.00	22.00	7.15	+48.1
West Texas intermediate (posted)	16.44	18.65	20.00	21.00	23.00	24.50	25.50	6.85	+36.7
MOTOR GASOLINE PUMP PRICE (average all types) ($/gallon)	0.931	0.995	1.100	1.150	1.200	1.250	1.300	0.305	+30.7

U.S. DEMAND

KEYS TO THE FUTURE

1. The U.S. economy will continue to expand over the forecast period. The rate of growth will be lowest in the initial years, but increasing to 3-4% in the 1990-1992 years.

2. Energy consumption will also move up over the forecast period. Conservation will continue but lower energy costs will diminish the intensity.

3. Petroleum product consumption will increase at a pace only slightly less than energy consumption.

4. Heavy fuel oil demand may pick up toward the end of the forecast period. Increased demand for fuel for electric power generation will boost resid demand.

5. The price of motor gasoline will move over the forecast period, following the price of crude oil. The highly competitive retail market will keep the relative price increase below crude oil.

U.S. Outlook
Supply

THE SHARP DROP IN PRICES dramatically changed the supply outlook for the U.S.. Lower prices are a double edged sword stimulating demand but depressing high cost production.

Over the past few years, U.S. supply was more predictable than demand. Since domestic demand far exceeds available domestic production, there has not been a problem selling domestic output. So availablity of domestic crude was dependent upon the price of crude oil and the related cost of production. With the price relatively high, U.S. production was maintained at a high level. Actually, U.S. supply had been moving up slowly. The U.S. industry had been able to raise the necessary capital to exploit the available hydrocarbons. But a substantial volume of U.S. production is relatively high-cost production. This high-cost production is more sensitive to a drop in the price of crude than production in some other areas of the world.

As a result, the sharp drop in crude prices in 1986 had a major impact on U.S. production. At this lower price, thousands of uneconomic wells were shut in and a lot of exploration and production work was curtailed.

"Since U.S. domestic production is unable to support total domestic demand for petroleum products, a substantial volume of imports is required."

In the past, the supply response to price changes had been slower than the demand response. This huge drop in prices, however, resulted in a much faster domestic supply response. In the long run, demand for petroleum products can only be met by domestic production or imports of crude and products.

Since U.S. domestic production is unable to support total domestic demand for petroleum products, a substantial volume of imports is required. Imports are the swing supply source, and vary with demand. But the future picture is rather clear. With increasing demand and declining production, increased imports will be required to fill the widening gap between domestic demand and domestic supply.

In the short run crude and product stocks can help to satisfy demand but only temporarily. Stocks have already been cut down close to minimum operating requirements and therefore will not provide a major source of supply over the forecast period.

REVIEW

TOTAL PRODUCTION. The precipitous drop in the wellhead price of U.S. crude oil in 1986 had a substantial impact on U.S. production. Due mainly to the drilling boom of 1980-1982 U.S. crude production had been generally rising from 1979 through 1985. This trend was reversed abruptly in 1986.

U.S. crude and condensate production declined from 9.477 million b/d in 1972 to 8.132 million b/d in 1976, a drop of 1.345 million b/d, or 14.2%. With the development of the Alaskan North Slope, production jumped to 8.707 million b/d in 1978. But the decline in Lower-48 production showed through again in 1979 as total U.S. production fell to 8.552 million b/d.

The high domestic crude prices resulting from the OPEC price increase of 1979-1981 stimulated domestic exploration and development. At these higher prices, production from many marginal low-volume U.S. wells became profitable. Initially, the drilling boom arrested

U.S. LIQUIDS PRODUCTION AND RESERVES

	1973	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	% change 78/73	% change 86/78	% change 86/73
	(1,000 b/d)															
Crude & condensate production:																
California	921	883	892	958	935	966	975	1,055	1,100	1,109	1,126	1,161	1,114	1.5	19.1	21.0
Kansas	181	162	160	158	153	156	164	180	193	196	207	207	184	15.5	20.3	1.7
Louisiana	2,278	1,796	1,686	1,542	1,460	1,355	1,283	1,231	1,256	1,314	1,408	1,392	1,403	35.9	3.9	38.4
New Mexico	276	259	251	239	230	217	206	196	195	206	217	215	207	16.7	10.0	25.0
North Dakota	55	56	59	64	64	84	110	124	130	139	144	139	125	16.4	95.3	127.3
Oklahoma	524	447	441	428	418	393	410	422	435	435	460	446	409	20.2	2.2	21.9
Texas	3,546	3,347	3,251	3,117	2,948	2,776	2,672	2,589	2,535	2,473	2,472	2,435	2,300	16.9	22.0	35.1
Wyoming	389	349	319	306	376	361	345	358	324	324	340	352	332	3.3	11.7	14.7
Others	839	872	887	904	872	843	815	808	785	778	783	799	739	3.9	15.3	11.9
Total Lower 48	**9,009**	**8,171**	**7,946**	**7,716**	**7,456**	**7,151**	**6,980**	**6,963**	**6,953**	**6,974**	**7,157**	**7,146**	**6,813**	**−17.2**	**−8.6**	**−24.4**
Alaska	199	191	173	463	1,245	1,402	1,617	1,609	1,696	1,714	1,722	1,825	1,867	525.6	50.0	838.2
Total U.S.	**9,208**	**8,362**	**8,119**	**8,179**	**8,701**	**8,553**	**8,597**	**8,572**	**8,649**	**8,688**	**8,879**	**8,971**	**8,680**	**−5.5**	**−0.2**	**−5.7**
NGL production:																
Total U.S.	1,738	1,633	1,603	1,618	1,567	1,584	1,573	1,609	1,550	1,559	1,630	1,609	1,551	−9.8	−1.0	−10.8
Total liquids production:																
Total U.S.	10,946	9,995	9,722	9,797	10,268	10,137	10,170	10,181	10,199	10,247	10,509	10,580	10,231	−6.2	0.4	−6.5
	(Million bbl)															
Total U.S. Reserves:																
Crude	35,299	32,682	30,942	29,486	27,804	27,051	29,805	29,426	27,858	27,735	28,446	28,416	24,560	−21.2	−11.7	−30.4
NGL	6,455	6,268	6,402	5,994	5,926	5,655	6,728	7,068	7,221	7,901	7,643	7,944	7,170	−8.2	21.0	11.1
Total	**41,754**	**38,950**	**37,344**	**35,480**	**33,730**	**32,706**	**36,533**	**36,494**	**35,079**	**35,636**	**36,089**	**36,360**	**31,730**	**−19.2**	**−5.9**	**−24.0**
	(Years)															
Reserves/production ratio:																
Crude	10.50	10.71	10.44	9.88	8.75	8.67	9.50	9.40	8.82	8.75	8.75	8.68	7.75			
NGL	10.18	10.52	10.94	10.15	10.36	9.78	11.72	12.04	12.76	13.89	12.81	13.53	12.67			
Total	**10.45**	**10.68**	**10.52**	**9.92**	**9.00**	**8.84**	**9.84**	**9.82**	**9.42**	**9.53**	**9.38**	**9.42**	**8.50**			

Source: American Petroleum Institute; Energy Information Administration

CRUDE AND PRODUCT IMPORTS: RELATION TO DEMAND

	1973	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	% change 78/73	% change 86/78
	(1,000 b/d)														
Imports:															
Crude*	3,244	4,105	5,287	6,594	6,195	6,452	5,219	4,141	3,323	3,096	3,229	3,083	4,130	+ 91.0	− 33.3
Products	3,012	1,951	2,026	2,193	2,008	1,937	1,646	1,599	1,625	1,722	2,011	1,866	2,945	+ 33.3	+ 1.8
Total	**6,256**	**6,056**	**7,313**	**8,787**	**8,203**	**8,389**	**6,865**	**5,740**	**4,948**	**4,818**	**5,240**	**4,949**	**6,175**	**+ 31.1**	**− 24.7**
Domestic demand	17,308	16,322	17,461	18,431	18,847	18,513	17,056	16,058	15,296	15,231	15,726	15,726	16,281	+ 8.9	− 13.6
Dependency ratio:															
Imports/demand	36.2	37.1	41.9	47.7	43.5	45.3	40.3	35.8	32.4	31.6	33.3	31.5	37.9		

* Excludes imports for Strategic Petroleum Reserve.
Source: Energy Information Administration

the decline and U.S. production remained fairly constant, with 8.597 million b/d in 1980 and 8.572 million b/d in 1981.

Over the next four years production moved up. The substantial accumulation of new wells coupled with increased Alaskan output to boost total production to 8.971 million b/d in 1985. The higher prices and corresponding increase in drilling activity helped boost U.S. production 399,000 b/d, up 4.7%. This increase in U.S. domestic production was a direct result of the increase in the price of crude oil. This rapid increase in price stimulated domestic exploration and drilling and encouraged the development of previously uneconomic reserves. The drilling and development surge over the 1979-1982 period helped slow the expected decline rate in the Lower-48 states. In fact Lower-48 output actually moved up over the 1981-1985 period.

Prior to the drilling boom the decline in Lower-48 production had been somewhat masked by increased Alaskan production. Lower-48 production fell from 9.275 b/d in 1972 to 6.953 million b/d in 1982, a drop of 2.322 million b/d, down 25%.

Effects of the drilling boom began to show up in 1983, as Lower-48 output moved up marginally to 6.974 million b/d. This was an increase of 21,000 b/d; only 0.3%, but a complete reversal of the expected constant rate of decline. Lower-48 production continued to move up in 1984 with estimated output of 7.157 million b/d. Production in 1985 was sustained at close to this level with 7.146 million b/d.

Sliding prices had slowed drilling activity from 1983-1985. But the sharp drop in prices in 1986 led to a drop in drilling activity to the lowest level ever recorded. Coupled with the shutting in of marginal wells this led to a drop of Lower-48 production of 333,000 b/d, 4.7%, to 6.813 million b/d for 1986. This was the lowest level of Lower-48 production since 1955. Without a high level of domestic drilling activity Lower-48 production is expected to continue to slide.

Part of the Lower-48 decline of 1986 was offset by increased Alaskan production. Alaskan production moved up to a record high 1.867 million b/d in 1986. The Alaskan North Slope was developed in 1977 and 1978. The first full year of North Slope production, 1978, Alaskan output was 1.229 million b/d. Production from the North Slope has been moving up steadily since then. Total Alaskan production in 1986 was up 638,000 b/d, 51.9% above the 1978 year of initial production. But Alaskan production is expected to peak in the next couple of years.

NGL production has not varied greatly over the past several years. Output varies with the relative economics associated with gas liquids products. It is dependent upon the cost of extraction versus the market value of the products. Producers have the flexibility of varying the extraction rate of liquids from gas, dependent upon the economics.

From 1975-1980, NGL output averaged 1.596 million b/d. Over the five years, 1981-1985, output has averaged 1.591 million b/d. Output hit a low of 1.55 million b/d in 1982, but was up to 1.63 million b/d in 1984 and 1.609

million b/d in 1985. As a result of lower prices NGL production fell sharply in 1986 to 1.551 million b/d. As a result of the decline in both crude oil and NGL output, total liquids production fell 347,000 b/d, 3.3% in 1986, down to 10.289 million b/d.

RESERVES. The level of oil reserves and the ratio of proven reserves to current production are key indicators of future production potential. Total U.S. liquids reserves at the end of 1985 were down 12.9% from 1973, but end 1985 reserves were up 11.1% from 1979. The drilling boom in the U.S. from 1979-1982, that followed the sharp increase in prices, slowed the expected decline in U.S. reserves and temporarily reversed the long-run decline. But in 1986 reserves dipped sharply falling 12.7% to 31.7 billion bbl. Reserves were down 24% from the 1973 level.

"Since domestic demand is moving up and domestic production is on the decline that gap is widening and imports are once again on the rise."

The reserves-production ratio has followed a similar pattern. But due to the higher level of production in the 1983-1985 period, the ratio moved down. The reserves-production ratio was 10.68 years in 1975. This fell sharply to 8.84 years in 1979 before the drilling boom. The ratio jumped to 9.84 years in 1980 and 9.82 years in 1981 along with the increased drilling activity.

The ratio slipped to 9.42 years by 1985. It then slipped in 1986 to 8.5 years. This is an historic low for this ratio and should serve as a signal that action should be taken to stimulate exploration activity. Replacing reserves is essential to the long-term viability of the U.S. domestic industry and to U.S. energy security. But it is apparent that a massive exploration and drilling effort is essential to accomplish this.

IMPORTS. Since U.S. liquids production is not sufficient to meet U.S. demand, imports are required to fill the gap. Imports are the swing source of petroleum and vary with the magnitude of the gap between domestic demand and domestic production.

Since domestic demand is moving up and domestic production is on the decline that gap is widening and imports are once again on the rise. The imports of concern are industry imports. Imports for the strategic petroleum reserve are not included in this analysis. They are more of a national security cost at this point in time. And until their role in meeting supply need is better defined, the SPR reserves are not a factor in the demand-supply equation.

Total imports peaked in 1977 at 8.787 million b/d. As demand fell, imports were reduced, rather than domestic production. Imports fell to 4.818 million b/d in 1983, down 3.969 million b/d, 45.2%. Demand fell 3.616 million b/d over the same period, 1978 through 1983. All of this decline in demand resulted in a drop in imports. In addition, increased domestic production and stock adjustments backed out an additional 353,000 b/d in imports.

Total imports jumped up in 1984 to 5.24 million b/d, but slipped again in 1985 to 4.949 million b/d. Increased domestic production and a drop in crude and product stocks in 1985 enabled a reduction in imports. But by end 1985 stocks had been drawn down close to minimum levels. Therefore, any increase in demand would have to be met by

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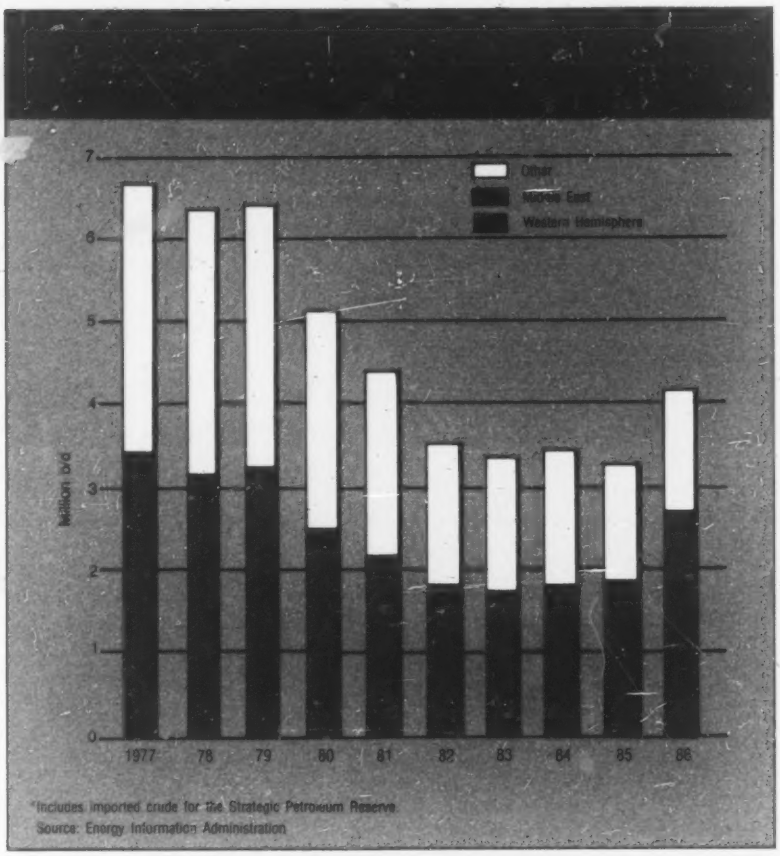


SPOT MARKET VOLUMES

Year	U.S. Imports (Thousand barrels per day) Total industry imports	Fixed price contract	Spot market
1975	6,056	5,871	185
1976	7,313	7,018	295
1977	8,786	8,346	440
1978	8,201	7,751	450
1979	8,389	7,884	505
1980	6,866	6,386	480
1981	5,740	5,165	575
1982	4,948	3,958	990
1983	4,817	2,887	1,930
1984	5,240	2,358	2,882
1985	4,949	985	3,964
1986	6,176	620	5,556

Note: Spot market volumes include for 1983 and 1984 contract volumes where the price is directly related to spot market prices and fluctuates with the spot market prices. This might be more aptly labeled "volumes traded on the spot market and at market related prices."

Source: Energy Information Administration and Author's estimates

STOCK LEVELS AND DAYS' SUPPLY

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Stocks (1,000 bbl)												
Crude oil*	271,354	285,471	339,813	309,421	339,080	358,166	363,464	349,730	343,850	345,376	320,892	331,224
Products	855,537	810,417	947,479	896,003	911,784	926,262	889,843	786,367	730,698	760,346	704,561	749,723
Total	**1,126,891**	**1,095,889**	**1,287,292**	**1,205,424**	**1,250,864**	**1,284,482**	**1,253,307**	**1,136,097**	**1,074,548**	**1,105,722**	**1,025,453**	**1,080,947**
SPR†	—	—	7,540	58,798	117,687	123,938	230,341	293,827	379,089	450,505	493,316	511,565
Demand (1,000 b/d)												
Products supplied	16,322	17,461	18,431	18,847	18,513	17,056	16,058	15,296	15,231	15,726	15,726	16,281
Days supply												
Product stocks	52.42	46.41	51.41	47.54	49.25	54.31	55.41	51.41	47.97	48.35	44.80	46.05
Total stocks	**69.04**	**62.76**	**69.84**	**63.96**	**67.57**	**75.31**	**78.04**	**74.27**	**70.55**	**70.31**	**65.21**	**66.39**

*Excluding SPR †Strategic Petroleum Reserve

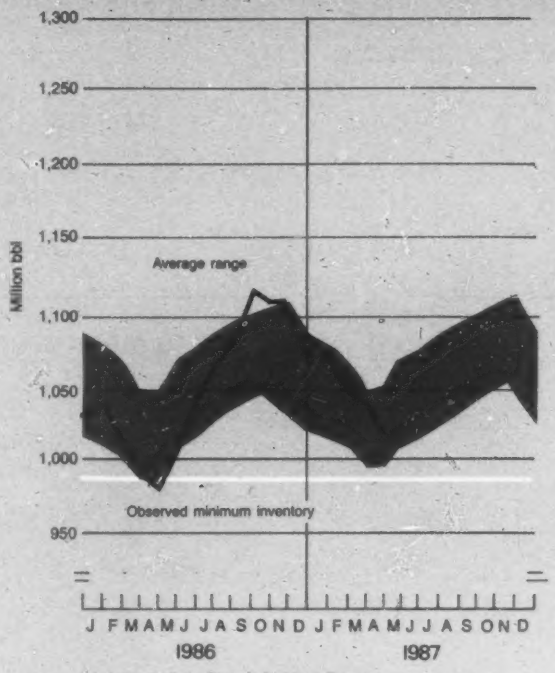
Source: Energy Information Administration

CRUDE IMPORTS BY COUNTRY OF ORIGIN

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
					(1,000 b/d)					
Eastern Hemisphere:										
Algeria	544	634	608	457	261	90	176	194	84	78
Angola	17	6	39	37	45	42	71	85	104	102
Egypt	36	20	55	31	33	40	25	10	3	10
Gabon	35	38	42	25	35	40	59	57	51	25
Libya	704	638	642	549	317	23	—	—	—	—
Nigeria	1,130	910	1,069	843	611	510	301	207	280	437
Other Africa*	34	30	42	62	32	30	48	65	62	89
Total Africa	**2,500**	**2,276**	**2,497**	**2,004**	**1,334**	**775**	**680**	**618**	**584**	**741**
Kuwait	42	5	5	27	—	2	7	24	4	28
Oman	74	61	37	24	24	22	34	10	2	8
Qatar	67	64	31	22	7	7	—	4	—	12
Saudi Arabia	1,373	1,142	1,347	1,254	1,112	530	321	309	132	618
United Arab Emirates	333	389	281	173	77	81	18	90	35	38
Other Middle East*	606	623	395	38	6	38	58	23	72	100
Total Middle East	**2,495**	**2,280**	**2,096**	**1,538**	**1,226**	**680**	**438**	**460**	**245**	**804**
Indonesia	507	533	380	315	318	226	315	304	292	297
Malaysia	55	37	55	61	33	18	3	—	1	11
Other Far East*	—	—	—	1	—	11	7	40	56	80
Total Far East	**562**	**570**	**435**	**377**	**351**	**255**	**325**	**344**	**349**	**388**
Norway	48	104	75	144	114	102	65	112	31	53
United Kingdom	97	169	197	174	369	441	365	378	278	317
Other Europe*	5	10	8	—	—	—	3	3	1	9
Total Europe	**150**	**275**	**280**	**318**	**483**	**543**	**433**	**493**	**310**	**379**
Other Eastern Hemisphere†	8	8	3	—	37	54	91	120	53	30
Total Eastern Hemisphere	**5,715**	**5,409**	**5,311**	**4,237**	**3,431**	**2,307**	**1,967**	**2,035**	**1,541**	**2,342**
Western Hemisphere:										
Brazil	—	—	—	1	14	19	2	—	—	—
Ecuador	55	38	30	17	38	22	56	47	56	64
Mexico	177	316	436	508	469	645	766	658	715	621
Peru	—	18	40	41	30	21	8	1	12	9
Trinidad-Tobago	—	—	—	115	102	92	83	87	98	93
Venezuela	250	181	293	156	147	155	164	253	305	416
Other Latin America*	1	2	—	3	—	—	4	1	0	63
Total Latin America	**483**	**555**	**799**	**841**	**800**	**964**	**1,083**	**1,047**	**1,186**	**1,266**
Canada	279	248	271	200	164	214	274	341	468	570
Other Western Hemisphere†	138	144	124	—	1	3	5	3	6	0
Total Western Hemisphere	**900**	**947**	**1,194**	**1,041**	**965**	**1,181**	**1,362**	**1,391**	**1,660**	**1,836**
Total Crude Imports	6,615	6,356	6,505	5,278	4,396	3,488	3,329	3,426	3,201	4,178
Less: SPR Imports	20	162	67	44	256	165	234	197	118	48
Crude Imports (ex. SPR)	6,595	6,194	6,438	5,234	4,140	3,323	3,095	3,229	3,083	4,130
OPEC Imports	5,643	5,184	5,112	3,864	2,922	1,734	1,477	1,512	1,312	2,113
% OPEC Imports	85.3%	81.6%	78.6%	73.2%	66.5%	49.7%	44.4%	44.1%	41.0%	50.6%

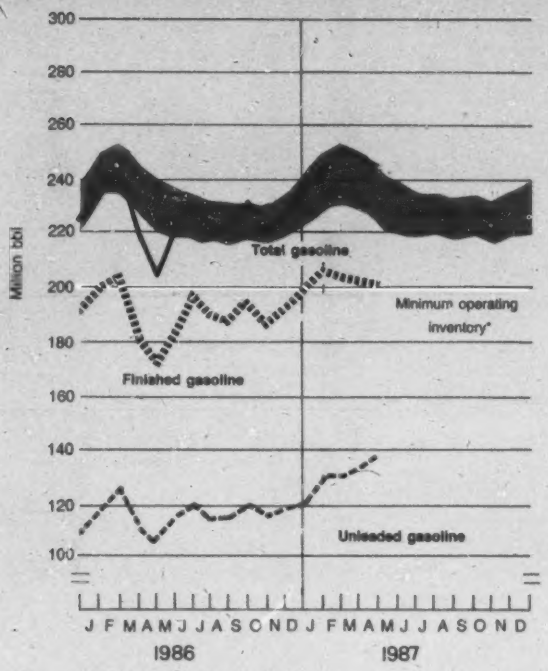
*May include data on countries listed specifically but for which no individual data are reported.
†Includes data which could not be broken down by country or continent.
Source: Energy Information Administration.

Crude oil & pet. prod.*



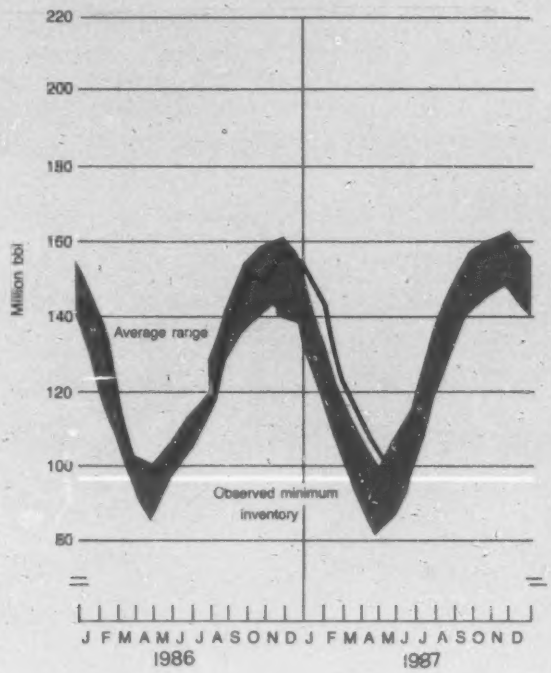
*Excludes stocks for Strategic Petroleum Reserve
Source: Energy Information Administration

Motor gasoline



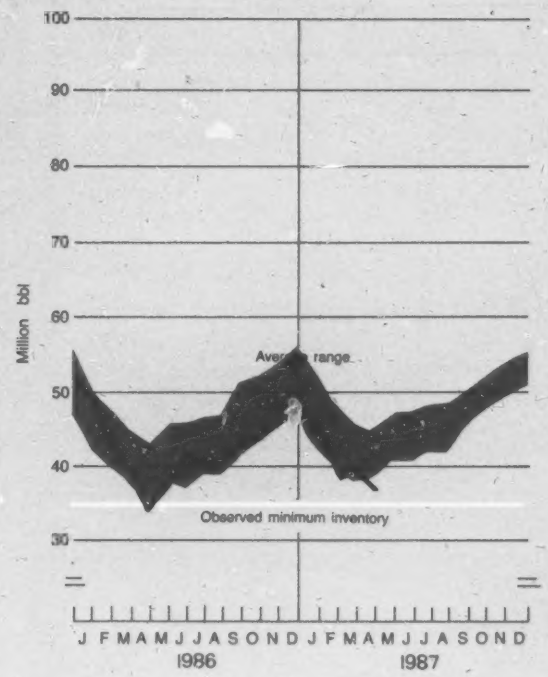
*National Petroleum Council estimate
Source: Energy Information Administration

Distillate fuel oil



Source: Energy Information Administration

Residual fuel oil



Source: Energy Information Administration

increased imports.

Imports jumped up sharply in 1986 as demand increased and domestic production fell. Total imports increased 24.8% in 1986 to 6.175 million b/d. This was the highest volume of imports since 1980.

"With excess domestic refining capacity, domestic refiners should have more incentive to import crude, rather than products."

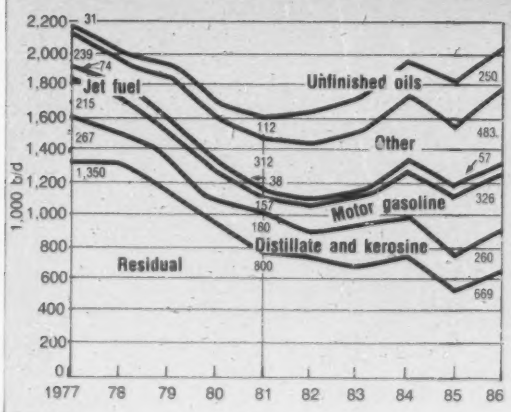
Most of the decline which occurred in the years 1977-1983 was in crude oil imports, which fell 3.498 million b/d, from 6.594 million b/d in 1977 to 3.096 million b/d in 1983, a drop of 53%. Product imports fell 471,000 b/d, 21.5%, from 2.193 million b/d to 1.722 million b/d in 1983.

Crude imports jumped up in 1984 to 3.229 million b/d but then fell again in 1985 to 3.083 million b/d. The decline in 1985 was due to increased domestic production and destocking. Crude imports jumped 34% in 1986 to 4.178 million b/d. The drop in domestic production coupled with the increase in demand led to the need for more imported crude oil. In addition, refiners took advantage of the low priced crude market to boost crude stocks 3.1%.

Product imports actually hit bottom in 1981 at 1.599 million b/d. They then moved up substantially between 1981 and 1984, increasing 25.8% to 2.011 million b/d. Product imports fell to 1.866 in 1985, primarily due to a reduction in product stocks that added 153,000 b/d to supply in 1985. Product imports jumped back up again in 1986, increasing to 2.045 million b/d, an increase of 179,000 b/d. A substantial portion of this increase was an increase in resid imports which moved up 159,000 b/d in 1986; in response to the jump in resid demand, U.S. refiners are not presently set up to optimize resid production so this sudden surge in demand was met by imports.

With excess domestic refining ca-

REFINED PRODUCT IMPORTS



Source: Energy Information Administration

REFINED PRODUCT IMPORTS

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
					1,000 b/d					
Gasoline	215	190	181	140	157	197	247	299	381	326
Kerosine	19	11	9	10	7	13	11	12	8	13
Jet fuel-kerosine	53	67	55	49	31	23	29	48	30	48
Jet fuel-naphtha	21	19	22	31	7	5	1	14	9	9
Distillate	248	173	196	142	173	93	174	272	200	247
Residual	1,350	1,355	1,150	941	800	776	699	681	510	669
Unfinished oils	31	27	58	55	112	174	234	231	318	250
Other*	239	165	264	283	312	344	327	454	410	483
Total U.S.	2,176	2,007	1,933	1,651	1,599	1,625	1,722	2,011	1,866	2,045

*Includes plant condensate

pacity, domestic refiners should have more incentive to import crude, rather than products. This would enable refiners to increase crude runs and lower unit costs. With the pattern of demand relatively uncertain, crude imports offer refiners additional flexibility. They can change yield patterns as required by demand.

But with excess refining capacity worldwide, products are available at low prices, making product imports economically attractive, and flexibility can be retained by simply importing the product required. As additional export refineries come on stream in the Middle East, and U.S. import requirements increase, product imports may move up. The determining factor will obviously be the cost of crude and processing, relative to the cost of imported products.

Import dependency dropped sharply from 1977 to 1983. Total imports as a percentage of domestic demand has risen from 29.1% in 1972 to a peak of 47.7% in 1977. With declining imports, this ratio fell to 31.6% in 1983. The rebound in imports in 1984 pushed it back up to 33.3%. With the drop in imports in 1985, the dependency ratio fell to 31.5%. With the surge in imports in 1986 the dependency ratio shot up to 37.9%. This ratio is expected to climb over the forecast period. The import dependency ratio is a key indicator of U.S. vulnerability to some form of oil supply disruption. Another indicator is the source of oil imports.

As imports declined between 1977 and 1985, and the dependency ratio fell, the source of imports was shifted away from some of the more volatile areas. Imports from OPEC countries and the Persian Gulf were reduced and thus reduced the U.S. vulnerability to an oil supply disruption.

Crude imports from the Persian Gulf countries were reduced substantially, falling from 2.495 million b/d in 1977 to 245,000 b/d in 1985. Imports from OPEC countries fell 4.331 million b/d, from 5.643 million b/d in 1977 to only 1.312 million b/d in 1985. The share of U.S. crude imports from OPEC countries fell from 85.7% in 1976 to 41% in 1985.

Non-OPEC crude imports to the U.S. moved up from 972,000 b/d in 1977 to 1.889 million b/d in 1985. Mexico was the leading source of U.S. imported crude in 1985, supplying 715,000 b/d. Canada was second, supplying 468,000 b/d. Venezuela provided 305,000 b/d, Indonesia 292,000 b/d, Nigeria 280,000 b/d and the United Kingdom 278,000 b/d. This favorable trend away from vulnerability was abruptly reversed in 1986. Crude imports from the OPEC countries jumped up to 2.113 million b/d, an increase of 61.1%. The OPEC share of U.S. crude imports increased to 50.6%. Imports from the Middle East also increased moving up to 804,000 b/d in 1986 from only 245,000 b/d in 1985. Saudi Arabia became the second leading source of imported crude providing 618,000 b/d. Mexico was the leading source at 621,000 b/d.

STOCKS. In the long run, stocks will not have a major impact on the supply situation. However, in the short run, stock swings can play a major role

NEW YORK MERCANTILE EXCHANGE

Total annual contract volumes
Thousand contracts
(Million barrels)

Year	Total oils	Crude oil	Heating oil	Leaded gasoline*	Unleaded gasoline
1978	50	—	50	—	—
1979	100	—	100	—	—
1980	240	—	240	—	—
1981	1,010	—	950	60	—
1982	1,850	—	1,725	125	—
1983	2,625	350	1,850	425	—
1984	4,589	1,840	2,092	654	3
1985	6,989	3,981	2,208	667	133
1986	12,858	8,314	3,275	830	439
1987 (6 mo.)	9,160	6,234	1,870	—	1,056

Trading vs. Deliveries
(Thousand barrels)

	Total deliveries	Trading volume	Deliveries as % of trading volume
Crude oil			
1984	65,780	1,494,976	4.5
1985	157,991	3,581,102	4.4
1986	276,127	7,312,164	3.8
Heating oil			
1984	28,772	2,117,019	1.4
1985	29,861	2,069,901	1.4
1986	48,216	3,034,981	1.6
Unleaded gasoline			
1985	6,684	116,252	5.7
1986	14,068	276,619	5.1

* Leaded gasoline trading ended Oct. 1986

in determining the level of supply, the level of imports, and most significantly the short run price of crude and products. Stocks can be another source of crude oil and petroleum products. But when on the rise they can also be an element of demand. A review of stock movements can be of value in understanding the changes in the overall supply demand situation.

Total crude and product stocks, excluding stocks for the Strategic Petroleum Reserve (SPR), fell 210 million bbl from year-end 1980 to year-end 1983. This added an average 192,000 b/d to available supply over that three-year period. Stocks went up marginally, 30 million bbl, in 1984 as demand increased, but were reduced again in 1985 as refiners cut costs. Stocks fell an additional 80 million bbl, and at year-end 1985 were down 259 million barrels from year-end 1980. This had added 142,000 b/d to supply

U.S. REFINED PRODUCTS, NATURAL GAS LIQUIDS, AND CRUDE STOCKS

Refined product stocks	1977	1978	1979	1980	1981	1982*	1983	1984	1985	1986
	1,000 bbl									
Gasoline	260,624	245,694	240,159	264,011	256,425	247,085	225,042	246,307	225,148	235,490
Motor†	257,578	237,885	237,503	261,327	253,001	244,279	222,434	243,296	222,839	233,057
Aviation†	3,046	2,809	2,656	2,684	3,424	2,806	2,608	3,011	2,309	2,433
Special naphthas	4,024	4,071	4,196	4,929	3,965	3,474	3,153	2,951	3,909	3,759
Kerosine	15,015	14,334	15,821	11,568	11,042	10,792	7,861	11,893	7,502	8,379
Distillate	250,280	216,367	228,706	205,113	191,541	185,579	140,263	161,072	143,673	155,097
Residual	89,673	90,204	95,859	91,786	77,992	68,229	48,504	53,000	50,381	47,437
Kerosine jet fuel	28,283	27,707	32,926	35,723	34,011	32,001	32,346	35,118	33,825	42,677
Naphtha jet fuel	6,285	5,960	5,594	6,308	7,054	7,189	6,265	6,861	6,654	7,072
Natural gas liquids & LRG	128,518	134,890	125,597	137,460	150,170	114,497	116,817	108,446	81,707	109,532
Unfinished oils	113,190	108,723	117,652	123,938	111,348	105,277	108,018	93,506	106,656	94,022
Other refined products	48,577	53,053	45,274	45,426	46,295	44,023	42,429	41,192	45,106	46,258
Total product stocks	**947,479**	**896,003**	**911,784**	**926,262**	**889,843**	**818,146**	**730,698**	**760,346**	**704,561**	**749,723**
*Crude stocks§	339,813	309,421	339,080	358,166	363,464	350,044	343,850	345,376	320,892	331,224
Total stocks	**1,287,292**	**1,205,424**	**1,250,864**	**1,284,482**	**1,253,307**	**1,168,190**	**1,074,548**	**1,105,722**	**1,025,453**	**1,080,947**

*Change in Energy Information Administration reporting basis †Includes blending components §Excludes stocks for Strategic Petroleum Reserve

Source: Energy Information Administration

over these five years. Stocks moved up again in 1986 increasing 55 million barrels. This actually added approximately 150,000 b/d to demand in 1986.

In the past stocks were built up substantially at certain times of the year to meet seasonal swings in demand. In addition, the industry was willing to hold stocks as a buffer against a potential supply disruption. Stocks were also retained, prior to 1981 because of uncertainty about the extent of the decline in demand.

But the philosophy changed as stocks piled up and carrying costs soared. The high inflation rates of the early 1980's made it quite expensive to maintain excess unneeded stocks. To cut costs a concentrated effort was made to reduce stocks to the minimum level operationally feasible. Stocks were slashed and the general philosophy of refiners is to maintain stock levels at a minimum.

The build up in stocks in 1986 was mainly a result of the extremely low prices and the netback pricing schemes that existed at the time. Refiners built up stocks to take advantage of the low crude costs. And many of the netback pricing arrangements made it highly profitable for refiners to purchase large quantities of crude. They were virtually assurred of a profit on all transactions.

That stock build up was only temporary. A substantial portion of the stock build up in 1986 had been worked off by mid 1987 and refiners were back to operating at minimum stock levels.

A good measure of the adequacy of stocks to meet demand is the number of days of supply they represent. Total industry stocks represented 58-days' supply in 1973. This increased to 78 days at year-end 1981. After the sharp reduction in stocks, there was some concern about the adequacy of stock levels, but stocks at year-end 1984 still represented over 70-days' supply at the reduced demand level of 1984. The additional sharp cut in stocks in 1985 dropped the days' supply represented by year-end 1985 total stocks to 65.2 days.

AVERAGE ANNUAL PRICE OF CRUDE OIL

Year	U.S. average wellhead price		Saudi Arabian light crude	
	Current dollars	Constant 1967 dollars	Current dollars	Constant 1967 dollars
1950	2.51	3.07	—	—
1951	2.53	2.78	1.75	1.92
1952	2.53	2.86	1.75	1.98
1953	2.68	3.07	1.97	2.25
1954	2.78	3.17	1.97	2.25
1955	2.77	3.15	1.97	2.24
1956	2.79	3.08	1.97	2.17
1957	3.09	3.31	2.08	2.23
1958	3.01	3.18	2.08	2.20
1959	2.90	3.06	1.90	2.00
1960	2.88	3.03	1.80	1.90
1961	2.89	3.06	1.80	1.90
1962	2.90	3.06	1.80	1.90
1963	2.89	3.06	1.80	1.90
1964	2.88	3.04	1.80	1.90
1965	2.86	2.96	1.80	1.86
1966	2.88	2.89	1.80	1.80
1967	2.92	2.92	1.80	1.80
1968	2.94	2.87	1.80	1.76
1969	3.09	2.90	1.80	1.69
1970	3.18	2.88	1.80	1.63
1971	3.39	2.98	2.29	2.01
1972	3.39	2.85	2.48	2.08
1973	3.89	2.89	5.04	3.74
1974	6.74	4.21	11.25	7.03
1975	7.56	4.32	12.38	7.08
1976	8.19	4.48	11.51	6.29
1977	8.57	4.41	12.70	6.54
1978	9.00	4.30	12.70	6.07
1979	12.64	5.37	24.00	10.19
1980	21.59	8.03	32.00	11.91
1981	31.77	10.83	34.00	11.59
1982	28.52	9.53	34.00	11.36
1983	26.19	8.64	29.00	9.57
1984	25.88	8.34	29.00	9.35
1985	24.09	7.80	28.00	9.07
1986	12.66	4.22	15.05	5.02
1987E	14.85	4.88	17.45	5.73

Note: Prices for Saudi Arabian light crude are official government posted prices 1950–1985 average selling price 1986–1987

This was the lowest level since 1974. This moved up slightly to 66.4 days of supply at year end 1986.

Most of the reduction in stocks has been product stocks. From year-end 1981 to year-end 1986 total industry stocks have been reduced 173 million barrels. Crude stocks have been reduced only 32 million barrels while product stocks have fallen 141 million barrels. Refiners find it to maintain higher crude stocks. With excess refining capacity available, refiners can run crude to meet unexpected swings in product demand.

"Crude oil stocks in the Strategic Petroleum Reserve surpassed industry crude oil stocks in July 1983."

The refining and distribution network is continously being adjusted to increase efficiency and cut operating costs, and this includes minimizing stocks. But stocks appear to be at a minimum level if supply disruptions are to be avoided. With demand expected to rise in the future it does not appear that stocks will be reduced any further.

Crude oil stocks in the Strategic Petroleum Reserve surpassed industry crude oil stocks in July 1983. At year end 1986 SPR stocks were 512 million barrels while industry crude stocks were only 331 million barrels. The fill rate for the SPR has become sort of a political football. Those placing emphasis on energy security push for a higher fill rate. While those concerned more with government expenditures and budget deficits call for a lower fill rate or total suspension of SPR crude purchases. The domestic independent producers have asked that it be filled partially with crude from domestic stripper wells so that these wells are not shut-in.

The SPR does potentially provide a back-up in case of an emergency. However, at year end 1986, it represented only about 31.4 days of supply at the 1986 rate of demand. But the biggest problem with the SPR program is that there is no clear cut procedure for its use in case of an emergency. Without some program for implementation, the SPR is of little use in preventing a surge in prices if there is a supply disruption.

One final element of supply is processing gain from refining operations. This expansion during crude processing added 785,000 b/d to supply in 1986. It is anticipated that with demand in general going up, and demand for light products growing, processing gain will move up over the forecast period.

An added element of risk was added to the crude supply market and refinery crude trading operations over the past several years. The excess capacity situation in the world crude market led to a very competitive trading atmosphere in crude oil products. This resulted in the rapid expansion of spot market transactions and the development of a futures market for major products and crude oil. Transactions became dominated by spot market trading. The netback pricing arrangements eliminated some of the risk for refiners during 1986. But many of those arrangements were short-lived or were reduced in scope, in 1987.

Although OPEC is trying to reestablish posted contract prices, the vast majority of the trading is still spot market trading with its inherent risks. More and more refiners and others involved in trading products or crude are turning to the futures market to

reduce the risk.

Total annual contract volumes traded on the New York Mercantile Exchange moved up from 50,000 contracts in 1978 (50 million barrels) to 6,989,000 contracts in 1985, and 12,858,000 in 1986. The futures market has become an important barometer of the volatile movement in prices in today's market. Just how it will eventually influence supply is not known but it should be watched closely.

THE SHARP DROP IN CRUDE OIL PRICES in 1986 brought the decline curve back into U.S. domestic crude oil production projections. And although prices rebounded from the extreme lows of mid-1986, they have recovered only a part of the pre-1986 level.

The average wellhead price for U.S. domestic crude oil fell 47.4% from $24.09/bbl in 1985 to $12.66/bbl in 1986. This was a loss of $11.43/bbl. The estimated average price for 1987 is $14.85/bbl. Only $3.42, 30% of the decline was recovered.

Although OPEC is trying to reestablish posted contract prices the vast majority of the trading is still spot market trading with its inherent risks.

As a result of this loss of value, U.S. crude production fell 3.2%, 291,000 b/d, from 8.971 million b/d in 1985 to 8.680 million b/d in 1986. The decline from December 1985 to December 1986 was 678,000 b/d. The decline in production was a result of a combination of two factors. Well drilling activity fell to an all time low with an average of only 964 rotary rigs active during 1986. And secondly, a vast number of marginal stripper wells were shut in either permanently or temporarily during 1986, and their production was eliminated.

Of greater long-term significance is the drop in drilling activity. Without constant drilling activity the natural decline curve of the U.S. production begins to take over. The high oil prices of the 1980-1985 period helped boost U.S. domestic production. A surge in exploration and drilling resulted in the development of smaller reservoirs and prevented the natural decline curve from taking hold in the older producing areas of the lower-48 states. In fact, Lower-48 production increased 166,000 b/d from 6.98 million b/d in 1980 to 7.146 million b/d in 1985.

The slide in crude oil prices between 1981 and 1985 cut drilling activity substantially, but the vast number of additional wells and investment in enhanced oil recovery helped sustain production. At this present low level of drilling activity, the decline of the Lower-48 states production cannot be held back, as it was in the 1979-1985 period. Even though drilling activity is expected to pick up with higher prices, over the forecast period, it will not be sufficient to thwart the decline. And in addition, Alaskan production is expected to peak in the near future and start to decline.

Therefore, U.S. production is projected to decline throughout the forecast period. Crude and condensate production is expected to slide downward each year and fall to 7.37 million b/d by 1992. This is a drop of 11.8%, 990,000 b/d over the forecast period. Production in 1992 will be down 1.601 million b/d from the 8.971 million b/d in 1985, before prices plummetted. NGL production is expected to drop only marginally

over the forecast period, falling to 1.56 million b/d in 1992. Natural gas production is expected to move up toward the end of the forecast period. In addition liquids prices will be higher and give an economic incentive to maintaining a high level of processing.

U.S. total liquids production is projected to fall to 8.93 million b/d in 1992, down 10.3% from 1987. By the end of the forecast period U.S. total liquids production will have fallen to the lowest level since 1963.

"Replacing reserves is essential to the long-term viability of the domestic industry and to U.S. energy security, but worldwide economic forces do not presently support exploitation of these higher-cost domestic resources."

This is actually quite an optimistic view of U.S. production over the next five years. It assumes that the increase in prices over the forecast period will stimulate drilling activity. The two are quite closely correlated. And this forecast assumes that U.S. drilling activity will continue to operate at a high level of efficiency. This means getting more footage and wells out of an active rig.

Higher prices will also enable producers to maintain stripper well production over a longer period. Coupled with the higher rate of drilling activity this should slow the decline rate from that experienced in 1986.

In addition, increased production from offshore California should help slow the decline rate of Lower-48 production. And Alaskan production may not fall as sharply as some are estimating.

Even though drilling activity is expected to pick up over the forecast period, it will still be a much lower pace than in the recent past. With this lower rate of drilling activity it will be impossible to prevent a steady decline in U.S. liquid reserves over the forecast period. It is expected that reserves will decline faster than production and that the reserves production-ratio will also decline over the forecast period.

It has been estimated that a massive exploration and drilling effort would have to be launched in order to slow the decline. Replacing reserves is essential to the long-term viability of the domestic industry and to U.S. energy security, but worldwide economic forces do not presently support exploitation of these higher-cost domestic resources. If the energy security issue is of concern, then the government will have to take action to assist the industry by reducing the tax burden or eliminating other restrictions.

Lower domestic production and increasing domestic demand translate into a widening gap between domestic supply and domestic demand that will have to be filled by imports. Total industry imports, excluding crude imports for the Strategic Petroleum Reserve (SPR) are projected to increase 35.7% over the 1987-1992 period. Imports will move up 2.28 million b/d, to 8.66 million b/d in 1992. This would be up 75% from the 4.949 million b/d imported in 1985. Imports in 1992 will be close to a record high and, if events change, could easily set a new high. The previous annual record was 8.786 million b/d in 1977.

Crude oil imports will lead the way, increasing 48.7% over the forecast period to 6.66 million b/d. This will be a record high for crude oil imports. The previous high was 6.594 million b/d also in 1977.

Because of the excess refining capacity available in the U.S., product

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imports are not expected to rise as rapidly. Product imports are forecast to increase 5.3% to 2 million b/d in 1992. This situation could change however if foreign products become available at prices lower than domestic products. In that case product imports could increase substantially.

With declining U.S. production and increasing imports, dependency on imported oil will increase markedly over the forecast period. Total imports as a percentage of domestic demand will move up from 39% in 1987 to 49.4% in 1992. This will be an all time high. The previous high was 47.7% in 1977.

Net imports (total imports less exports), as a percentage of domestic demand, will increase from 34.1% in 1987 to 44.7% in 1992. This will be just short of the all time high of 46.4% in 1977. By the end of the forecast period, the U.S. will be back to a dependency on foreign oil that equals or exceeds that of the late 1970's. And the imports will be more vulnerable to supply disruptions and economic disruptions.

"With declining U.S. production and increasing imports, dependency on imported oil will increase markedly over the forecast period."

Since non-OPEC production is not expected to increase over this period, the additional imports will have to come mainly from OPEC sources. Imports from OPEC countries are expected to increase to close to 70% of total U.S. crude imports by the end of the forecast period.

Stocks will not play a major role in the supply picture over the forecast period. Stocks are presently at close to a minimum level for operational efficiency. Expectations are that stocks will be increased as demand moves up over the forecast period.

THE OUTLOOK — U.S. SUPPLY

	1986	1987	1988	1989	1990	1991	1992	Change 1987 to 1992	% change 1987 to 1992
PETROLEUM BALANCE (thousand barrels/day)									
DEMAND:									
Domestic demand	16,281	16,370	16,520	16,640	16,970	17,270	17,530	1,160	+ 7.1
Exports	785	800	800	810	810	820	820	20	+ 2.5
Total demand	**17,066**	**17,170**	**17,320**	**17,450**	**17,780**	**18,090**	**18,350**	**1,180**	**+ 6.9**
SUPPLY:									
Crude production	8,680	8,360	8,190	7,950	7,710	7,540	7,370	-990	-11.8
NGL & other hydrocarbons	1,611	1,590	1,580	1,570	1,570	1,560	1,560	-30	-1.9
Total liquids	**10,291**	**9,950**	**9,770**	**9,520**	**9,280**	**9,100**	**8,930**	**-1,020**	**-10.3**
Crude imports (ex. SPR)	4,100	4,480	4,490	5,260	5,820	6,260	6,660	2,180	+48.7
Product imports	2,045	1,900	1,900	1,920	1,940	1,960	2,000	100	+ 5.3
Total imports	**6,175**	**6,380**	**6,800**	**7,180**	**7,760**	**8,230**	**8,660**	**2,280**	**+35.7**
Other supply	752	755	760	770	780	790	800	45	+ 6.0
Total supply	**17,218**	**17,085**	**17,330**	**17,470**	**17,820**	**18,120**	**18,390**	**1,305**	**+ 7.6**
TOTAL STOCKS: (million barrels)									
Crude stocks	331	330	330	330	335	335	340	10	+ 3.0
Product stocks	750	720	725	730	740	750	760	40	+ 5.6
Total industry stocks	**1,081**	**1,050**	**1,055**	**1,060**	**1,075**	**1,085**	**1,100**	**50**	**+ 4.8**
SPR crude stocks	512	540	565	590	615	645	670	130	+24.1
Total U.S. stocks	**1,593**	**1,590**	**1,620**	**1,650**	**1,690**	**1,730**	**1,770**	**180**	**+11.3**
Industry stocks — days supply	66.4	64.1	63.9	63.7	63.3	62.8	62.7	-1.4	-2.2
Net imports — % of domestic demand	33.1	34.1	36.3	38.3	41.0	42.9	44.7	10.6	+31.1
Total imports — % of domestic demand	37.9	39.0	41.2	43.1	45.7	47.7	49.4	10.4	+26.7
CRUDE OIL PRICE ($/barrel)									
U.S. average wellhead	12.66	14.85	16.25	17.50	19.25	21.00	22.00	7.15	+48.1
West Texas intermediate	16.44	18.65	20.00	21.00	23.00	24.50	25.50	6.85	+36.7

KEYS TO THE FUTURE

1. Relatively low crude oil prices will not stimulate exploration sufficiently to stop the slide in U.S. crude production.

2. Lower-48 production will continue its natural decline and Alaskan production will peak and start down. Total domestic liquids production will fall 10.3% by 1992.

3. The average wellhead price of U.S. crude oil will move up 48% over the forecast period but will still be below the 1980—1985 level.

4. Increasing demand and falling production will result in a substantial increase in imports. Total imports will move up 35% over the forecast period. Imports will be a record 49.4% of U.S. domestic demand by 1992.

5. The domestic refining industry will continue to operate as efficiently as possible, minimizing crude and product stock levels.

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Capital Expenditures

THE LEVEL OF U.S. OIL AND GAS INDUSTRY CAPITAL EXPENDITURES is a direct reflection of the amount of money flowing into the industry. The level of cash flow is tied to the sales volume or demand and the price level. And in recent years the most volatile element of cash flow determination has been the price level.

Prior to the 1970's there was relatively little price movement. Change in industry cash flow was determined by the change in the demand for crude, petroleum products and natural gas. And since this was an era of constantly rising demand, cash flow into the industry was steadily rising. During this period investment decisions were financed by expectations of increasing demand.

But the relationship changed in the 1970's. There was a shift in capital spending planning to a closer dependency on price movements. For the oil and gas industry, spending and prices have been tied extremely closely over the recent boom-bust cycle from 1977 to 1986. This has been a cycle of great amplitude with prices moving up sharply between 1977 and 1981, and then falling back again from 1981 through 1986. Capital expenditures have followed the same cycle, rising rapidly from 1977 through 1981 and then falling again from 1981 through 1986.

REVIEW

UPSWING. U.S. oil industry capital spending has gone through an amazing cycle over the past ten years: a boom-bust period of historic proportions. And it was all due to the swings in the price of 'oil.'

The average wellhead price of domestic crude oil went up from $9.00/bbl in 1978 to $31.77/bbl in 1981. This was a jump of $22.77/bbl, 253%, in just three years. The average cost of imported crude oil increased from $13.30/barrel in 1978 to $35.10/barrel in 1981, an increase of 163.9%. The average refiner acquisition cost of crude oil, both domestic and imported, increased from $12.46/barrel in 1978 to $35.24/barrel in 1981, an increase of 182.8%. It should be noted that in 1978 there were still price controls on some domestic U.S. production and therefore the average domestic price was below the world price.

Over this short three-year span the total value of U.S. crude production at the wellhead went up from $13.1 billion in 1973 to $28.6 billion in 1978. It then jumped to $99.4 billion in 1981. This came about even though U.S. crude production in 1981 was down 6.9% from 1973 and down 1.6% from 1978.

Just based on wellhead value of domestic production, industry revenues had moved up $86.3 billion from 1973 and $70.8 billion from three year earlier 1978. When refined product sales are taken into consideration, the increased revenue is substantially greater. Product prices moved up along with crude prices increasing the revenue accruing to the oil industry.

In response to this tremendous surge in industry revenue, industry capital spending shot up. Over the same three-year span, total U.S. oil industry capital spending went from $29.2 billion to $82.9 billion, an increase of 184.1%.

Over this upswing portion of the

U.S. CAPITAL SPENDING

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
	(Million $)									
Drilling-Exploration	14,172	15,079	21,926	31,789	43,193	40,965	28,193	28,290	26,596	13,240
Production	2,659	3,132	4,490	6,191	7,984	7,144	5,531	5,590	5,217	2,995
OCS lease bonus	1,569	1,767	4,590	4,205	6,599	3,800	5,749	4,037	1,488	187
Subtotal	**18,400**	**19,978**	**31,006**	**42,185**	**57,776**	**51,909**	**39,473**	**37,917**	**33,301**	**16,422**
Refining	1,324	1,551	2,735	3,159	5,131	5,775	4,142	2,914	2,992	2,073
Petrochemicals	1,746	2,675	2,355	2,805	2,792	2,031	1,112	1,215	493	1,357
Marketing	687	982	851	1,276	1,619	1,349	1,614	2,221	2,611	1,256
Crude & products pipelines	1,630	989	1,509	1,777	2,052	1,121	2,456	1,689	1,137	435
Gas pipelines	873	809	1,491	3,642	4,947	5,179	4,707	3,971	2,084	1,309
Other transportation	438	468	583	804	895	515	456	386	458	380
Miscellaneous*	1,593	1,738	3,700	5,022	7,731	7,760	4,567	4,347	3,706	3,258
Subtotal	**8,291**	**9,212**	**13,224**	**18,485**	**25,167**	**23,730**	**19,054**	**16,743**	**14,481**	**10,068**
Total	**26,691**	**29,190**	**44,230**	**60,670**	**82,943**	**75,639**	**58,527**	**54,660**	**47,782**	**26,490**

*Includes mining and other energy

Source: Oil & Gas Journal

U.S. CAPITAL SPENDING (CONSTANT DOLLARS)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
	(Million $)									
PPI*	1.942	2.093	2.356	2.687	2.934	2.993	3.031	3.103	3.088	2.998
Drilling & exploration	7,297.6	7,204.5	9,306.5	11,830.7	14,721.5	14,784.8	9,301.6	9,117.0	8,612.7	4,416.3
Production	1,369.2	1,496.4	1,905.8	2,304.1	2,721.2	2,900.4	1,824.8	1,801.5	1,689.4	999.0
OCS lease bonus	807.9	844.2	1,948.2	1,564.9	2,242.1	1,332.1	1,896.7	1,301.0	481.9	62.4
Subtotal	**9,474.8**	**9,545.2**	**13,160.4**	**15,699.7**	**19,691.9**	**19,017.4**	**13,023.1**	**12,219.5**	**10,784.0**	**5,477.7**
Refining	681.8	741.0	1,160.9	1,175.7	1,748.8	1,573.7	1,366.5	939.1	968.9	691.5
Petrochemicals	899.1	1,278.1	999.6	1,043.9	951.6	524.6	366.9	391.6	483.5	452.6
Marketing	353.8	469.2	361.2	474.9	551.8	446.7	532.5	715.8	845.5	418.9
Crude & prod pipelines	839.3	472.5	640.5	661.3	699.4	441.0	810.3	544.3	368.2	145.1
Gas pipelines	449.5	386.5	632.9	1,355.4	1,686.1	2,028.1	1,553.0	1,279.7	674.9	436.6
Other transportation	225.5	223.6	247.5	299.2	305.0	172.1	150.4	124.4	148.3	126.6
Mining & other energy	—	—	658.3	945.7	1,442.7	1,177.4	579.7	606.8	401.2	426.0
Miscellaneous	820.3	830.4	912.1	923.3	1,192.2	1,431.3	927.1	794.1	798.9	660.8
Subtotal	**4,269.3**	**401.3**	**5,612.9**	**6,879.4**	**8,577.7**	**7,794.9**	**6,286.4**	**5,395.7**	**4,689.4**	**3,358.3**
Total	**13,744.1**	**13,946.5**	**18,773.3**	**22,579.1**	**28,269.6**	**26,812.2**	**19,309.5**	**17,615.2**	**15,473.4**	**8,836.0**

*Producer's Price Index (1967 = 1.00)

OGJ GROUP* PROFITS AND CAPITAL SPENDING

	Net income ($ Million)	Capital & exploratory expenditures ($ Million)	Capital & exploration expenditures % of net income
1977	12,550.0	26,811.0	213.6
1978	13,779.0	42,265.0	306.7
1979	23,130.0	53,261.0	230.3
1980	29,326.8	52,065.0	177.5
1981	28,205.4	66,895.8	237.2
1982	23,079.7	60,357.0	261.5
1983	22,325.5	45,584.1	204.2
1984	20,078.1	51,422.8	256.1
1985	13,916.0	38,539.0	276.9
1986	9,564.0	26,445.0	276.5
Total 1977-1986	195,954.5	463,645.7	236.6

*Oil & Gas Journal group of 25-28 major oil companies

Source: Oil & Gas Journal

cycle, 1978 through 1981, exploration, drilling and production spending (including OCS lease bonus payments) increased from $20 billion to $57.8 billion, an increase of 189.2%. Spending on exploration and drilling activities alone increased from $15.1 billion in 1978 to $43.2 billion in 1981, an increase of 186.4%. Production outlays increased 154.9% to $8.0 billion in 1981. And OCS lease bonus payments by the industry jumped to $6.6 billion in 1981, up from $1.8 billion in 1978.

At the lofty prices for crude oil and higher natural gas prices, there were many more prospects that were economical for development. Even very marginally producing wells could be justified as profitable. At the time, expectations were for substantial additional price increases in subsequent years. As a result, in addition to much higher wellhead revenues, there was a lot of outside capital flowing into exploration and production activity.

Spending for all of the other segments of the industry grouped together increased at a similar pace. Outlay for refining, marketing, transport, etc. moved up from $9.2 billion to $25.2 billion, an increase of 173.2%. With higher prices, the cash flow into the industry moved up, and there were substantially more funds available for investing during this period. With adequate funds available, companies were expanding and upgrading other aspects of their operations: refining, petrochemicals, marketing and transportation. Some companies were diversifying into related industries, such as mining, or into other activities.

"Spending in 1986 was down to approximately the same level as 1977 when outlays totaled $26,691 million. From the peak in 1981, capital spending was cut by $56.5 billion."

DOWNTURN. Oil prices peaked in March of 1981 and started a long slide. Petroleum product prices followed along. This resulted in reduced funds available to the U.S. oil and gas industry for investment. This was somewhat offset by rising natural gas prices which continued to move up until 1984. But that didn't provide sufficient additional cash flow to prevent a sharp drop in capital spending.

As a result, U.S. oil and gas industry capital and exploration expenditures plummeted from the lofty levels of the 1981 and 1982 peak boom years. Capital spending by U.S. oil companies peaked in 1981 at $82,943 million. It fell to $75,639 million in 1982 and then dropped sharply to $58,527 million in 1983. Spending dropped in 1984 to $54,660 million and slipped again to $47,782 million in 1985. When prices fell in 1986, capital spending followed dropping precipitously to an estimated $26,490 million. Spending in 1986 was down to approximately the same level as 1977 when outlays totaled $26,691 million. From the peak in 1981, capital spending was cut by $56.5 billion.

"Although industry capital spending follows crude prices closely, corporate investment decisions are probably made with a closer eye to profits."

Total exploration drilling and production outlays accounted for $41.4 billion of the decline, falling from $57.8 billion in 1981 to an estimated $16.4 billion in 1986. This was a drop of 71.6% in the five years. Outlays in this area fell $16.9 billion in 1986 alone.

Spending on other activities also fell dramatically, but not as rapidly as exploration and production. All of the other capital spending together fell 60% from $25,167 million in 1981 to $10,068 million in 1986, a drop of $15,099 million.

Capital spending fell at about the same rate as crude prices. The average wellhead price of domestic crude oil fell from $31.77/bbl in 1981 to $12.66/bbl in 1986, a decline of 60.2%. Natural gas prices also began to fall in 1984 and the average wellhead price in 1986 was down 29.7% from the peak. Over this same period, there was also a drop in demand for petroleum products and natural gas, so the cash flow impact on individual companies was greater than reflected in just the price change.

INVESTMENT AND PROFITS. Although industry capital spending follows crude prices closely, corporate investment decisions are probably made with a closer eye to profits. But the level of profits is affected by many factors. So although capital spending and profits tend to follow each other, the relationship in any year can fluctuate greatly.

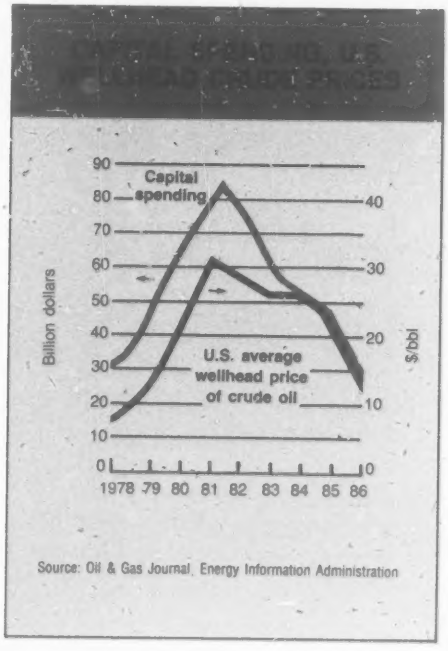
For the *Oil & Gas Journal* group of 25 oil companies, worldwide capital and exploration expenditures as a percentage of net income ranged from 177.5% in 1980 to 306.7% in 1978. The average from 1977 through 1986 was 236.6%.

This group of companies has maintained a high level of capital investment relative to profits, despite the downturn. Their planning horizons tend to be relatively long range. But with the low prices and the outside threat of takeovers, they will probably be forced to adhere more closely to the present short-range market philosophy of the investment community. The longer-range outlook might pay larger future returns, but most investors aren't looking very far into the future.

INTERNATIONAL SPENDING – U.S. FIRMS

	1982	1983	1984	1985	1986
			(Million $)		
Exploration-Production					
Drilling-Exploration	6,722	6,622	3,455	5,238	3,510
Production	3,570	2,940	1,831	2,688	2,270
Subtotal	**10,292**	**8,562**	**5,286**	**7,926**	**5,780**
Other					
Refining	781	696	808	959	692
Petrochemicals	602	467	219	245	372
Marketing	666	638	640	932	770
Pipelines	131	141	148	215	190
Other transportation	250	162	24	154	35
Mining & other energy	805	869	690	816	556
Miscellaneous	415	650	278	486	344
Subtotal	**3,650**	**3,623**	**2,807**	**3,807**	**2,959**
Total	**13,942**	**12,185**	**8,093**	**11,733**	**8,739**

Source: Oil & Gas Journal



In addition, many oil companies have been forced into reorganization to prevent hostile takeovers and dismemberment. The fall in prices and oil company revenues rapidly changed the perception that outside investors had of the future potential of the oil industry. Companies have been restructuring since the peak period by cutting costs and shedding surplus facilities. Outside interests saw a profit opportunity in forcing rapid restructuring. This has resulted in a wave of mergers, stock repurchase plans and other moves to fend off hostile takeovers. The result for many companies has been a substantial additional increase in debt. This has further reduced funds available for reinvestment.

The exploration, drilling and production segments of the domestic industry have been particularly hard hit by the lower prices. The lower prices have markedly reduced the wellhead revenues from crude oil and natural gas production. This has diminished the funds available for reinvestment in drilling activity. In addition, many companies have to use available funds to reduce the debt burden left over from the boom period.

The expectation of higher oil prices not only increased the flow of outside capital, but also encouraged a number of companies to increase their debt for expansion. As prices fell, the debt became a prohibitive burden. The necessity to repay the debt with funds from lower-valued oil has severely restricted the investment capability of many firms.

With oil prices down and pessimistic future price prospects, the flow of

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outside capital into the industry dried up. The glamour left oil investing, and the highly speculative funds that flowed into the industry in the 1979-1982 period, in anticipation of a potential high rate of return, are now being invested elsewhere.

The wellhead revenue reinvestment ratio, an indicator of the attractiveness of oil investing, fell to an extremely low level. Rig activity in 1986 fell to the lowest level recorded; at least the lowest level since the Hughes Tool Company started counting active rigs on a regular basis.

A ten-year cycle now seems to have been completed. The average wellhead price for domestic crude oil is estimated at $14.85/bbl in 1987. The average landed cost of crude oil imports in 1977 was $14.38/bbl. Total capital and exploration spending for 1987 is estimated at $25,415 million. Total spending in 1977 was $26,691 million.

OUTLOOK

The same general comments can be made about the future expectations for capital and exploration spending as were made a year ago. As was stated then, this may well be the start of a new cycle, but its beginning will not be as volatile as the last one. The last few years were a period of radical adjustment for companies in the industry. It was necessary for most to restructure and cut costs sharply. As the effects of the cost cutting begin to show up in improved profit, investment will respond. In addition, as the companies reduce the heavy debt load, investment can be increased. The lower debt load and improved profits will also attract outside funds into the industry.

However, it is not expected that there will be anything close to the surge in spending that occurred during the 1980-1982 period. Instead, capital expenditures will closely follow revenue and price movements, economic activity, and energy and oil demand.

Capital spending in the U.S. oil and gas industry will move the way of prices and profits over the forecast period, it will go up. Total outlays will move up 64% by 1992, from the depressed levels of 1987. Spending in 1992 will total $41,680 million up $16,265 million from 1987. Spending is expected to move up faster than prices over the forecast period as increased profitability returns to the industry.

U.S. domestic expenditures for exploration and production activities will also tend to follow the pattern of movement of oil prices over the forecast period. Spending in this sector of the domestic industry will increase steadily throughout the forecast period. Spending on exploration drilling, production and OCS lease bonuses is forecast to increase 93.8% over the five-year forecast period. Spending will increase to $28.31 billion in 1992 up $13.7 billion from 1987.

Spending for just the exploration and drilling segment is projected to increase 84.7%, up $10,064 million, to $21,940 million in 1992. The expected price rise for crude oil and natural gas will be a stimulant to drilling activity. And as prices move up some outside investment funds will return to the industry. This will be particularly true in the later years if prices move up more rapidly. The independent sector of

the U.S. domestic industry does the majority of the drilling, but relies heavily on outside investment funds. When prices appear a bit more certain, investors will return.

In addition, drilling costs have fallen sharply from their peak in 1982. This has improved the economics of exploration and drilling activity. With the large inventory and capacity surplus in the drilling and service, and supply industries, drilling costs will not move up very rapidly during the forecast period. In fact, drilling costs may remain relatively stable for the initial part of the forecast period. As prices move up the economics of exploration will improve and drilling activity should increase.

"Much of the excess capacity in the U.S. has been eliminated. But the industry is still quite competitive and there is more competition from foreign products."

It may also become obvious that there is a necessity to replace rapidly depleting domestic oil and gas reserves. This may result in more favorable tax treatment for the industry, and possibly even the removal of controls on natural gas. This would also give a boost to exploration and drilling activity as well as investment.

Spending on production facilities will follow drilling activity. Outlays will increase 88.3% over the forecast period, moving up to $4,870 million in 1992.

Outer continental shelf (OCS) lease bonus payments fell sharply from $6,599 million in 1981 to $1,488 million in 1985. Then in 1986, they almost dried up completely falling to only $187 million. And it is estimated that they will slip even further in 1987 to $148 million. It is expected that OCS bonus payments will increase over the forecast period as the economics of the available leases improve with the rising prices. It is expected that they will move back up to levels more comparable to the mid-1970's, by the end of the forecast period. The projection is for OCS bonus payments to rise to $1,500 million in 1992.

Spending on downstream facilities and other projects will not increase as rapidly over the forecast period, but spending will move up as higher prices make more funds available for investing. Outlays will increase 23.7% to $13,370 million in 1992. This is an increase of $2,565 million.

Refining and petrochemical investments remained at relatively high levels, even though demand for petroleum products fell for five consecutive years, 1978-1983. High levels of investment were viewed as essential for improved future profitability. Refiners cut back on overall distillation capacity, but continued to invest in upgrading facilities. Higher profitability is in increased yields of higher priced light products. Refiners also wanted the flexibility to use heavier, cheaper crudes as feedstock to cut costs.

Much of the excess capacity in the U.S. has been eliminated. But the industry is still quite competitive and there is more competition from foreign products. Refining lost some of the profitability it had attained in 1986 with the net back contracts. But it is expected that capital expenditures will move up over the forecast period as refiners try to continue to improve facilities and their profit margins. Investment in the petrochemical industry will concentrate on improving efficiency and reducing costs in the face of increasing foreign competition. Total spending for refining and petrochemical operations is projected to increase 22%

to $4,450 million in 1992.

Capital spending for marketing facilities is expected to continue to move up throughout the forecast period. The high level of competition in the marketing sector has stimulated investment as companies strive to maintain and/or gain market share. Spending is expected to increase 47.8% to $2,000 million in 1992. Transport spending for pipelines, tankers and trucks will be more sluggish but will increase 19.2% over the forecast period, moving up to $3,160 million.

Spending by U.S. oil companies for mining and other activities is expected to move up more moderately over the forecast period than other categories of spending. A number of companies have sold or discontinued their mining and metals operations. Outlays will increase 19.2% to $3,760 million in 1992.

International expenditures by a sampling of U.S. companies show estimated overseas outlays down in 1987. Spending plans for this group show total outlays of $8,415 million in 1987, down 3.7% from 1986. This is a much lower rate of decline then domestic spending which is estimated at being down 44.6%.

"Capital spending for marketing facilities is expected to continue to move up throughout the forecast period."

This is indicative of a shift to more investment in international activities. With lower cost, more profitable exploration and production activity possible overseas, U.S. companies will be diverting more of their investments to international operations than in past years. With the lower prices reducing the revenues flowing into many producing countries, it is possible to negotiate some attractive exploration agreements. Overseas downstream investments will probably continue to fall, however. The worldwide industry has a much larger refining and petrochemical overcapacity than the U.S., and new facilities in the Middle East have further added to the problem. Some investment will be shifted from U.S. domestic activities to the international scene, but the funds will be selectively invested in the most profitable sectors of the business.

THE OUTLOOK — CAPITAL EXPENDITURES

	1986	1987	1988	1989	1990	1991	1992	Change 1987 to 1992	% change 1987 to 1992
U.S. DOMESTIC OIL INDUSTRY CAPITAL EXPENDITURES (million $)									
Exploration & drilling	13,240	11,876	13,550	14,920	17,740	20,260	21,940	10,064	+84.7
Production	2,995	2,586	3,060	3,240	3,860	4,580	4,870	2,284	+88.3
OCS lease bonus	187	148	500	750	1,000	1,300	1,500	1,352	+913.5
Subtotal	**16,422**	**14,610**	**17,110**	**18,910**	**22,600**	**26,140**	**28,310**	**13,700**	**+93.8**
Refining & petrochemicals	3,430	3,648	3,820	3,970	4,170	4,350	4,450	802	+22.0
Marketing	1,256	1,353	1,480	1,600	1,750	1,910	2,000	647	+47.8
Pipelines and transport	2,124	2,650	2,730	2,890	2,980	3,110	3,160	510	+19.2
Mining and other	3,258	3,154	3,250	3,350	3,450	3,610	3,760	606	+19.2
Subtotal	**10,068**	**10,805**	**11,280**	**11,810**	**12,350**	**12,980**	**13,370**	**2,565**	**+23.7**
Total spending	**26,490**	**25,415**	**28,390**	**30,720**	**34,950**	**39,120**	**41,680**	**16,265**	**+64.0**
PRICES:									
Crude oil (Av. U.S. wellhead—$ barrel)	12.66	14.85	16.25	17.50	19.25	21.00	22.00	7.15	+48.1
Natural gas (Av. U.S. wellhead—$ mcf)	1.87	1.60	1.65	1.70	1.90	2.10	2.20	0.60	+37.5
Motor gasoline (Av. all types—$ gallon)	0.931	0.995	1.100	1.150	1.200	1.250	1.300	0.305	+30.7

CAPITAL EXPENDITURES

KEYS TO THE FUTURE

1. Rising prices for crude oil, petroleum products and natural gas will boost industry cash flow.

2. Total capital spending by the domestic industry will move up faster than prices over the forecast period. Profitability will improve with increased demand and more effeicient operations as well as increased prices.

3. The exploration, drilling and production sector of the business will post the most rapid rate of growth in capital spending over the forecast period.

4. Spending in all industry sectors will increase as the industry rebounds from the depression of 1986-1987.

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Exploration, Drilling and Production

THE EXPLORATION AND DRILLING SECTOR of the U.S. oil and gas industry is very volatile. This sector of the industry has gone through some extreme cycles during its history. But none of the previous cycles were as pronounced as the present one. In an industry known for its boom or bust periods this cycle stands out.

During this cycle, exploration and drilling activity in the U.S. went through a record high and hit a record low. From record high to record low was a period of only 4 1/2 years. And this in an industry that is one of the basic pillars supporting the U.S. economic system.

It has been an interesting period in the "oil patch." But the excitement is not completely over. This segment of the industry has been amazingly adept at rapidly adjusting to shifts in economic conditions. And I am confident that it will show the same resiliency in the near future. Activity has begun to move up and another cycle may be in the making.

REVIEW

RIG ACTIVITY. The number of active rotary drilling rigs is one of the key indicators of activity in the upstream portion of the U.S. domestic industry. And through the recent boom and bust cycle the number of active drilling rigs has followed the price of crude oil.

When the price of crude oil moved up rapidly between 1971 and 1981, the rig count followed. The number of active rotary drilling rigs increased from an annual average of 976 rigs in 1971 to a peak of 3,970 rigs in 1981. This was an increase of 2,994 active rigs, 306.8%. This size of domestic drilling activity quadrupled over that eleven-year span. This weekly count actually peaked at 4,530 active rigs during the last week of December, 1981.

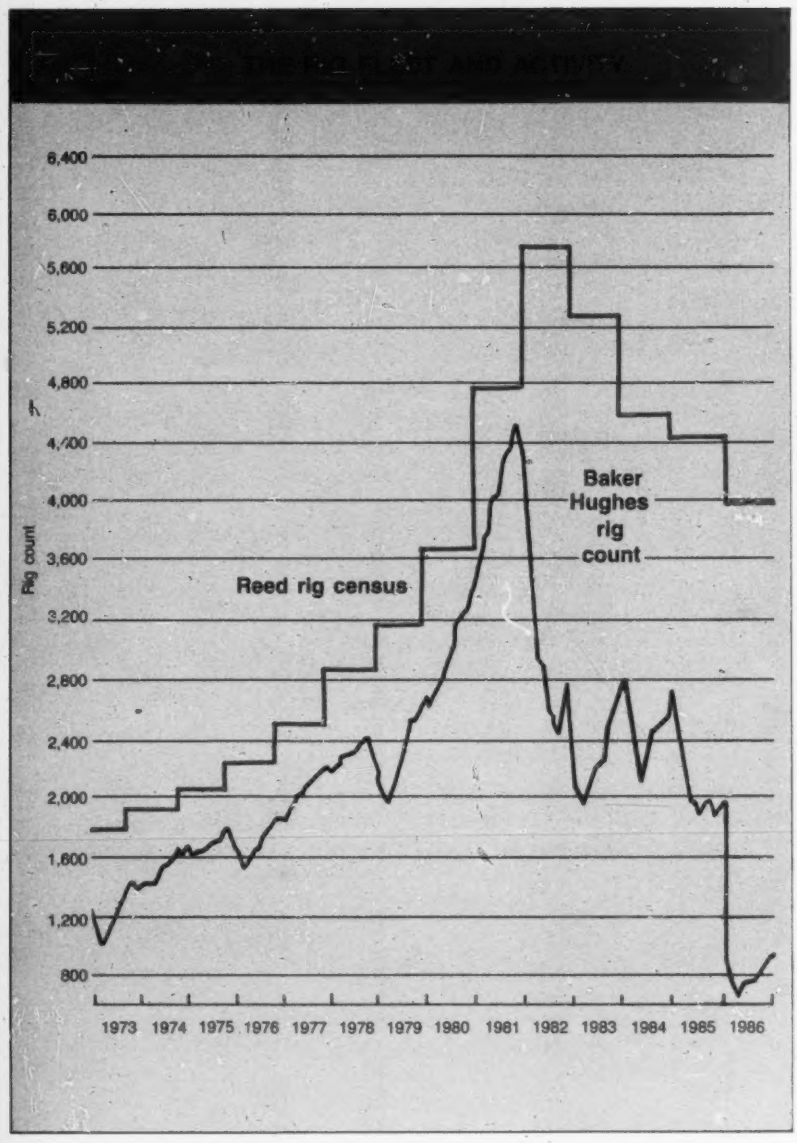
Then the rig count fell precipitously. The active rig count fell for ten consecutive months, hitting a 1982 low of 2,379 in October, and averaging 3,105 active rigs for the year. There was a slight seasonal upturn at the end of the year, but the count continued its decline. The number of active rigs fell to 1,807 in April 1983, 2,723 rigs lower than the peak, and a drop of 60.1%. The annual average for 1983 was 2,232 active rigs, down 1,738 rigs, 43.8% below the peak.

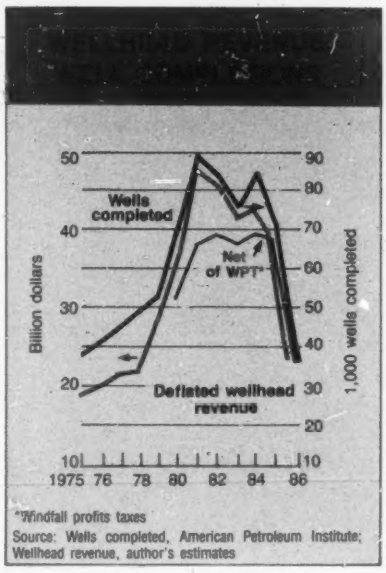
There was a slight upturn in 1984, as the rig count for the year averaged 2,428, but then the count slipped again, falling to an average of 1,980 in 1985. The year ended with a December average of 1,950 active rigs.

Then the count went on another precipitous fall, dropping to a record monthly low of 686 active rigs in July, 1986. The record weekly low was recorded July 14, 1986 at 663 rigs. This was a drop of 3,867 active rigs, 85.4%, in 54 months. The year ended with the lowest annual average rig count in history, 964 rigs.

The decline in crude oil prices was the main reason that the rig count fell. But there were a couple of other reasons why it fell so sharply.

Not only did prices begin to slide in 1981, but by the next year the long-range outlook for oil prices had changed dramatically. During the expansion phase of the boom, expectations were that oil prices were on the way to $50 per barrel and beyond. Prices actually turned around in February and March, 1981. The U.S. refiner acquisition cost of imported crude peaked in February, 1981 at $39/bbl. Domestic refiner acquisition cost and wellhead price peaked in March, 1981, at





WELL COMPLETIONS, FOOTAGE, AND ACTIVE RIGS

	Active rigs	Total well completions*	Total footage*	Average ft./well	Avg. wells per rig	Avg. ft. per rig
1973	1,195	27,692	139,424,738	5,035	23.17	116,673
1974	1,471	33,037	153,776,399	4,655	22.46	104,539
1975	1,660	38,884	181,039,993	4,656	23.42	109,060
1976	1,656	40,940	187,289,586	4,575	24.72	113,098
1977	2,001	45,855	215,695,878	4,704	22.92	107,794
1978	2,255	50,061	238,386,248	4,762	22.20	105,715
1979	2,176	51,890	243,685,430	4,696	23.85	111,988
1980	2,910	69,486	311,444,837	4,482	23.88	107,026
1981	3,970	89,234	406,520,453	4,556	22.48	102,398
1982	3,105	83,889	375,382,919	4,475	27.02	120,896
1983	2,232	75,738	316,617,464	4,180	33.93	141,854
1984	2,428	85,359	368,336,310	4,315	35.16	151,704
1985	1,980	70,703	316,270,000	4,473	35.71	159,732
1986	964	39,423	181,283,000	4,598	40.90	188,053

*Excludes service and stratigraphic wells and core tests.

Source: American Petroleum Institute and Baker Hughes Inc.

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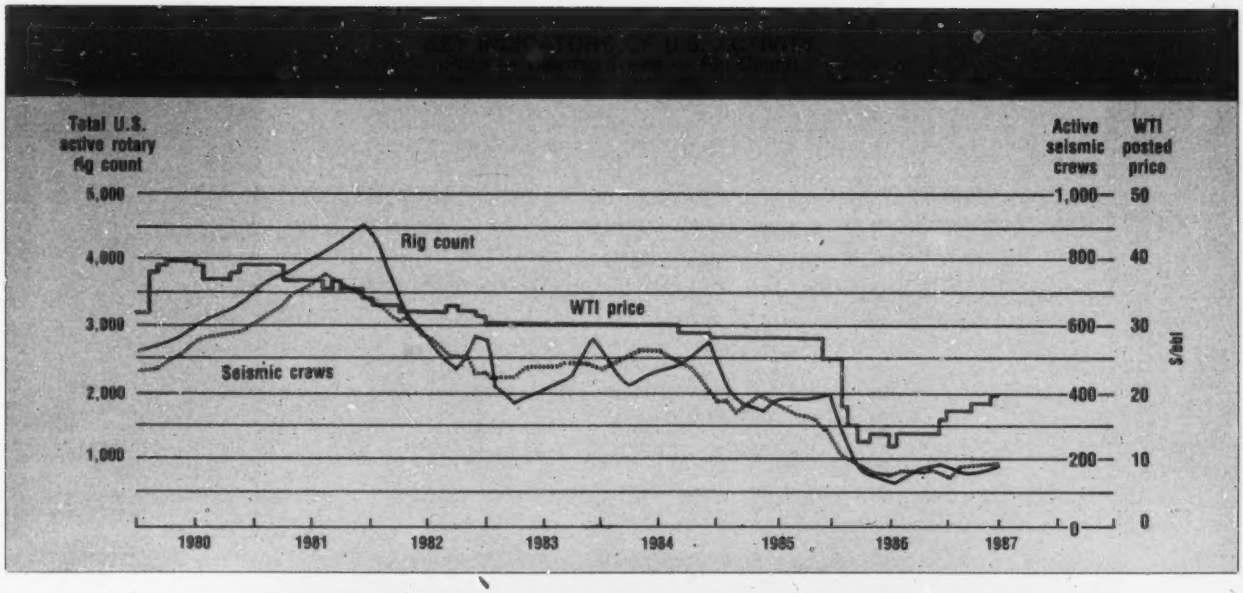

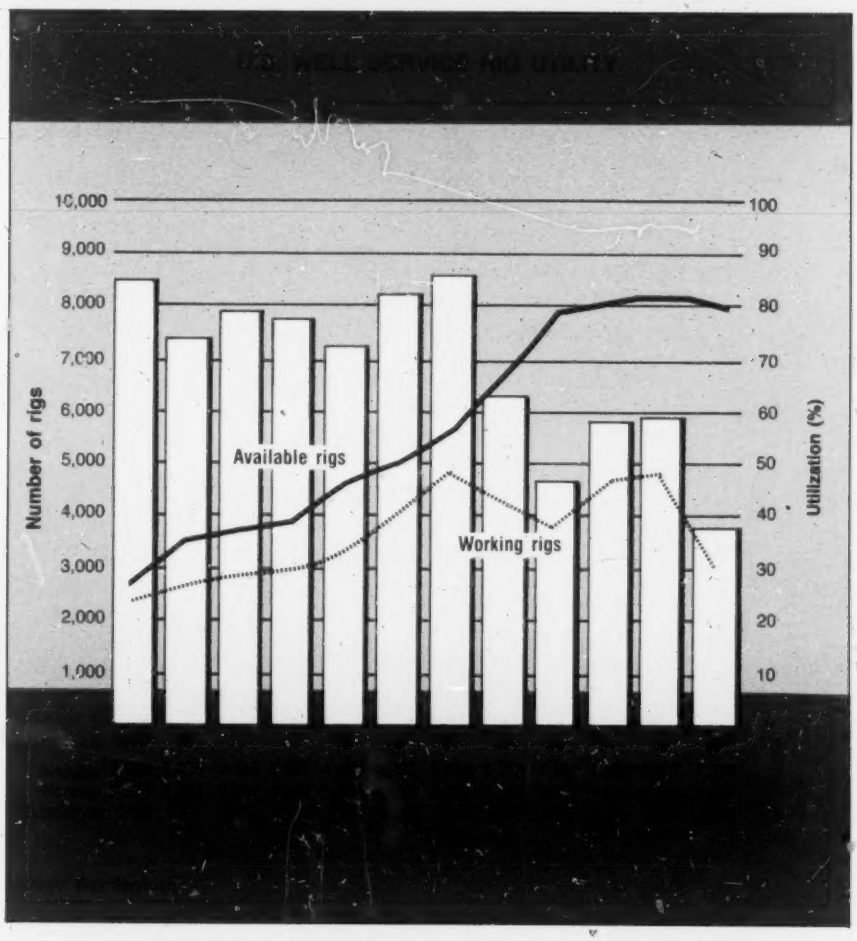

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$36.97 and $34.70, respectively.

Few analysts or investors picked up on the implications of the turnaround at that early date. Any leveling of prices was considered temporary or regional. Aggregate data prepared by the government was not available. It takes 3-5 months for government agencies to collect, aggregate and publish the information. And, at the prevailing prices, many projects were economical. So the drilling boom continued throughout 1981 and into 1982 as crude prices fell. But as prices continued the slide, prospects for near-future appreciation of the value of crude oil diminished considerably. Therefore, the outside investments declined. Part of the boom was financed by speculative investing, which tends to chase the highest expected rate of return. So, much of that investment money moved away from the petroleum industry.

Another reason for the rapid and extremely deep cut in drilling activity was the accumulation of debt by oil operators and producers. Actually the economics of drilling improved during the 1982-1985 period. Drilling costs fell faster than crude prices during this period. But many companies were unable to take advantage of this because of the debt burden they had accumulated during the boom.

Expectations that crude oil prices would reach $50/bbl and continue to climb stimulated the surge in drilling activity. With an industry consensus supporting this outlook for higher prices, investment funds flowed into the drilling industry, and banks actively sought investors in oil exploration projects. Funds were available and analysis supported investment, even if it required substantial debt. Everyone wanted to drill and many became burdened with debt. When prices fell, funds had to be diverted to handle the debt. The result was a sharper drop in activity than warranted by the basic economics.

With the upswing in prices in 1987 the rig count has started to move up again. It is expected to be over 1,000 by year-end 1987. However, it started the year at a very low level and therefore will post a record low annual average. It is expected that the number of active rigs will average about 920 for the year. But it is also expected that this will be the low point of the cycle and activity will improve, in the future years.

SEISMIC ACTIVITY. One of the better leading indicators of drilling activity in the U.S., is the level of seismic crew activity. It also went through a volatile cycle but slightly in advance of the rig count.

The seismic crew count also moved up rapidly during the drilling boom period. The number of active crews started its climb in April 1976 at 238 crews. And it hit a peak of 744 crews in September 1981. This was three months prior to the peak in drilling activity, and was one of the early warning signals of the downturn. The number of active seismic crews fell steadily to 447 in March, 1983. This was one month before the rig count hit bottom at 1,846 average active rigs in April. The number of active seismic crews moved up to 498 by October, 1983, an increase of 11.4%. The rig count moved up 38% from April to November, 1983. The seismic crew count fell slightly in early 1984, rose in mid-year and then fell at year-end. The seismic crew count fell sharply during the first half of 1985, leading the downturn in rig activity. It moved up marginally in the middle of 1985, but then started down again in August, 1985, again leading the decline in drilling activity. By September, 1986, the count had fallen to 155. This

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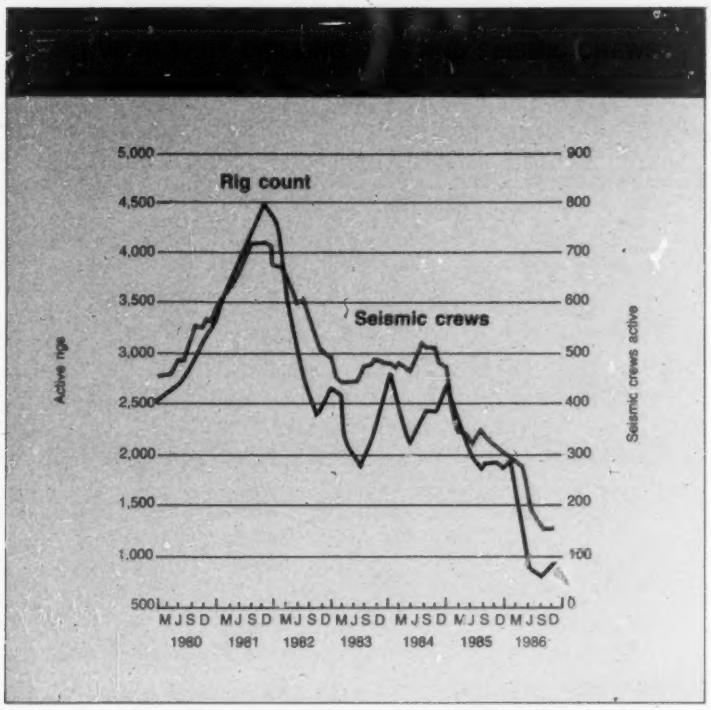

U.S. PRODUCING WELLS

	1978	1979	1980	1981	1982	1983	1984	1985	1986*
Well completions:									
Oil wells	19,065	20,689	32,120	42,520	39,252	37,396	44,472	36,370	18,802
Gas wells	14,405	15,166	17,132	19,742	18,810	14,505	14,962	12,899	7,940
Net abandonments:									
Oil wells	9,347	6,046	15,798	33,228	16,119	14,248	26,955	10,442	20,537
Gas wells	4,969	2,729	5,019	2,907	6,896	3,306	3,061	3,388	3,284
	14,316	**8,775**	**20,817**	**36,135**	**23,015**	**17,554**	**30,016**	**13,830**	**23,821**
Producing wells (Dec. 31):									
Oil wells	516,752	531,395	547,717	557,009	580,142	603,290	620,807	646,735	645,000
Gas wells	157,454	169,891	182,004	198,839	210,753	221,952	233,853	243,344	248,000
	674,206	**701,286**	**729,721**	**755,848**	**790,895**	**825,242**	**854,660**	**890,079**	**893,000**

*Estimates

Source: API, abandonments calculated by author

DRILLING COSTS*

	Total wells†	Total footage† (1,000 ft)	Total expenditures ($1,000)	Avg. cost per well	Avg. cost per foot
1973	26,244	136,661	3,074,532	117,152	22.50
1974	31,481	150,944	4,366,989	138,718	28.93
1975	36,960	177,642	6,571,214	177,793	36.99
1976	38,941	184,418	7,461,680	191,615	40.46
1977	43,826	212,694	9,956,453	229,181	46.82
1978	46,655	230,619	13,061,090	279,950	56.64
1979	48,523	237,512	16,078,930	331,367	67.71
1980	62,011	296,031	22,800,356	367,682	77.03
1981	80,816	388,800	36,665,456	453,691	94.30
1982	76,652	362,618	39,428,119	514,378	108.73
1983	67,536	301,226	25,104,543	371,721	83.35
1984	77,210	350,589	25,206,219	326,463	71.90
1985	67,821	314,490	23,696,603	349,399	73.35

*From the Joint Association Survey. †Doesn't agree with other reported figures because based on survey.

was down 79.2% from the peak. The count moved up a bit in late 1986 and early 1987 but then slumped again to 150 in March 1987. It started to move up again as oil prices stabilized and climbed. The count was 166 crews in May of 1987. It undoubtedly will move up along with the prices and rig count.

WELL COMPLETIONS. The increase in drilling activity in the 1971-1981 period resulted in a substantial surge in well completions. Total well completions increased from 26,268 in 1971 to 89,816 in 1981, an increase of 241.9%. This was a record high and far surpassed any previous year. There were 69,713 wells in 1980. Prior to that the record was only 57,182 in 1956.

Well completions fell slowly over the next few years. They slipped to 75,738 in 1983, but rebounded to 85,179 in 1984 and were still a high 70,708 in 1985. Over the period 1981-1985, 404,495 wells were completed, 80,889 per year. This gigantic number of well completions is one of the major reasons why U.S. crude production reversed its long-run decline and actually moved up between 1981 and 1985. It is also the reason why U.S. reserves of oil and natural gas were sustained over this period.

During the expansion period 1971 to 1981, well completions moved up 241.9%, but rig activity increased 306.7%. The reason for this was that rig efficiency declined somewhat over the period, as new, less efficient crews were employed on the new rigs, and deeper wells were being drilled. Well completions per active rotary rig fell from 26.9 wells in 1971 to 22.6 wells in 1981.

On the downswing, the opposite has

been true. From the peak in 1981, well completions have fallen more slowly than the Hughes rotary rig count. The number of well completions in 1982 was 83,889, down 6.6% from 1981. The rig count that year fell 21.8%. By 1985, the rig count had fallen 51%, to 1,980, but well completions were down only 21.3% from the peak. It should also be noted that the footage drilled has not fallen as fast as the rig count, but has remained more closely aligned to the well completions. The total footage drilled peaked at 406.5 million feet in 1981. This had dropped to 316 million feet in 1985, down 22.2%.

Well completions and the footage drilled have held up quite well when compared to the sharp drop in rotary rig activity. One of the reasons for this is an improvement in rig efficiency. The statistics would indicate a marked improvement in rig efficiency. The number of wells completed per active rig moved up to 35.7 in 1985. Rigs were working with more experienced crews and a good portion of the drilling was development drilling which is less time consuming.

"Although rig efficiency probably has improved, the actual improvement in productivity is probably marginal when measured annually."

During 1986 all of the indicators except rig efficiency collapsed. The active rig count fell another 51.3% to 964 rigs. The number of well completions fell 44.2% to 39,423 wells. The rig count was down 75.7% from the peak and well completions were down 56.1%. But the number of wells completed per active rotary rig climbed to 40.9.

The average number of wells greater than 2,500 feet completed per rig may be a better indicator of efficiency. This moved up from an average 16.7 during 1971-1981 to 18.2 in 1982. It then increased to 21.7 in 1983, 23.4 in 1984, 24.1 in 1985 and 27.1 in 1986. This may be a better measure of the improvement in rotary rig efficiency, since rotary rigs tend to be used for deeper wells.

Although rig efficiency probably has improved, the actual improvement in productivity is probably marginal when measured annually. One of the major reasons for the disparity between rig count and well completions may be the lack of statistical data covering all rig activity. The Hughes Tool Company weekly survey of rig activity records rotary rigs with the drilling depth capability greater than 2,500 feet. Many, if not most, of the shallower wells are drilled with other types of rigs, which are not counted in this weekly survey. Since shallower wells are far less costly, the drop in oil prices may not have had as big an impact on their activity. Therefore, a large percentage of the shallower drilling activity has continued during the downturn in the drilling industry. The ratio of total wells to rotary rig activity also measures the number of wells drilled with other types of rigs.

Also of note is the fact that the average depth of wells fell rather sharply from 4556 feet per well in 1981 to 4180 feet per well in 1983. Part of the reason for the drop in average depth was a shift away from deep gas well drilling and a concentration on shallow oil well drilling.

The drop in demand for natural gas and the slow-down of the climb in natural gas prices led to the curtailment of a substantial amount of natural gas drilling. Between 1979 and 1983, demand for natural gas fell 17%. This led to the present natural gas surplus and resulted in a decline in gas well drilling. This was particularly true for deep gas wells, below 10,000 feet. Close to 1,500 of the rigs that were idled were attributed to the decline in deep well drilling. The average depth has moved up in the last couple of years

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TOTAL WELLHEAD REALIZATIONS AND REINVESTMENT

	Total wellhead revenues ($1,000)	Net of WPT* ($1,000)	(JAS) Total drilling expenditure ($1,000)	Investment ratio (%)
1966	11,429,182		2,360,740	20.7
1967	12,274,468		2,299,178	18.7
1968	12,963,514		2,409,360	18.6
1969	13,882,295		2,610,671	18.8
1970	14,919,586		2,578,682	17.3
1971	15,778,480		2,371,492	15.0
1972	15,886,972		2,814,166	17.7
1973	17,951,977		3,074,532	17.1
1974	28,153,951		4,366,989	15.5
1975	32,061,121		6,571,214	20.5
1976	35,801,316		7,461,680	20.8
1977	41,615,676		9,956,453	23.9
1978	46,562,738		13,061,090	28.1
1979	63,164,966		16,078,930	25.5
1980	97,765,720	87,840,720	22,800,356	26.0
1981	138,947,637	113,003,637	36,665,457	32.4
1982	135,526,277	118,772,277	39,428,119	33.2
1983	124,592,334	113,924,334	25,104,543	22.0
1984	132,048,177	123,174,177	25,206,219	20.5
1985	122,047,638	118,047,638	23,696,603	20.1
1986E	69,192,044	69,192,044	11,797,240	17.0

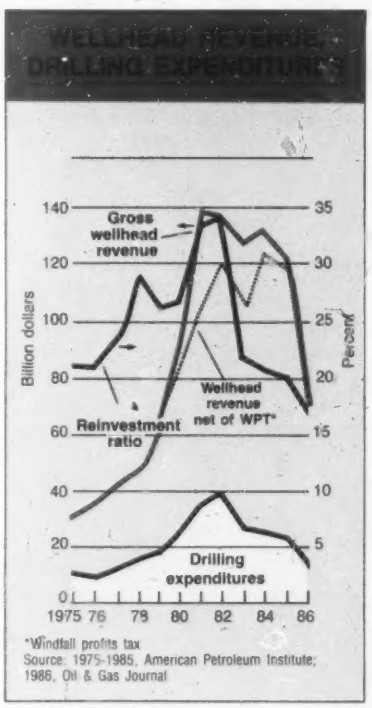
E-Estimate. *Windfall profit tax

Source: 1970-1985 API, 1986 Author's estimate

INDEX OF COST OF DRILLING AND EQUIPPING WELLS

(1984 = 100)	Weight (%)	1981	1982	1983	1984	1985	1986*
Payments to drilling contractors	29.8	157.0	163.6	114.3	100.0	101.0	85.9
Purchased items							
Road site preparation	6.3	86.5	90.9	96.7	100.0	101.7	106.5
Transportation	2.9	99.0	100.0	100.0	100.0	100.0	105.4
Fuel	1.2	114.3	111.6	101.8	100.0	95.3	58.9
Drilling mud and additives	5.8	136.6	141.0	107.5	100.0	100.6	100.6
Well site logging and or monitoring system	1.6	97.4	100.0	100.0	100.0	100.0	100.0
All other physical tests	0.5	94.9	100.0	100.0	100.0	100.0	100.0
Logs and wireline evaluation services	4.1	95.8	100.1	95.6	100.0	89.9	67.4
Directional drilling services	0.8	84.0	100.0	101.6	100.0	98.8	98.8
Perforate	2.0	91.5	100.0	100.0	100.0	100.0	100.0
Formation treating	4.2	128.0	118.8	105.9	100.0	94.5	89.3
Cement and cementing services	4.3	112.0	114.1	107.4	100.0	92.7	86.6
Casing and tubing	16.8	109.6	117.1	105.2	100.0	98.8	92.1
Casing hardware	0.7	109.6	117.1	105.2	100.0	98.8	92.1
Special tool rentals	3.1	93.4	103.3	103.3	100.0	100.0	100.0
Drill bits and reamers	1.6	89.0	92.6	99.9	100.0	100.4	98.8
Wellhead equipment	2.0	100.2	112.7	107.2	100.0	103.8	103.8
Other equipment and supplies	2.5	94.4	103.6	100.9	100.0	100.2	97.6
Plugging	0.7	91.8	97.9	98.5	100.0	98.1	97.4
Supervision and overhead	3.0	89.1	96.5	100.3	100.0	103.3	108.1
All other expenditures	6.1	94.3	96.9	97.9	100.0	100.4	96.8
Sub-total purchased items	**70.2**	**104.3**	**109.1**	**102.4**	**100.0**	**98.7**	**94.8**
Total†	**100.0**	**120.0**	**125.3**	**105.9**	**100.0**	**99.4**	**92.1**

*Preliminary. †Weighted according to 1982 weights for all years.
Source: IPAA



*Windfall profits tax
Source: 1975-1985, American Petroleum Institute; 1986, Oil & Gas Journal

TOTAL U.S. OPERATING OIL WELLS

	1978	1979	1980	1981	1982	1983	1984	1985	1986*
Flowing	31,927	34,786	34,529	38,060	36,065	32,994	36,104	37,665	37,000
Artificial lift	484,311	492,069	508,981	518,949	544,077	570,296	584,093	609,070	609,000
Total	516,238	526,855	543,510	557,009	580,142	603,290	620,197	646,735	646,000

*1986, Author's estimate

Source: American Petroleum Institute

reaching 4598 feet per well in 1986. This rise was due to a sharp drop in shallow well drilling, much of which had relatively poor reserve prospects.

WELLHEAD PRICES AND REVENUES. To better understand the recent volatile swings in exploration and drilling activity, it is best to look at the level of wellhead prices and wellhead revenues.

"Between 1971 and 1973, the average wellhead price of oil moved up 123%, and the rig count increased 70.1%."

Between 1971 and 1973, the average wellhead price of oil moved up 123%, and the rig count increased 70.1%. From 1975 to 1981, the average wellhead price increased 320.2%, and the rig count moved up 139.2%. Then, from 1981 through 1985, the average wellhead price fell 24.2% and the active rotary rig count fell 50%. And then in 1986, the average wellhead price collapsed, falling 47.4%, and the active rig count fell 51.3%.

On the upswing the average wellhead price of natural gas was also on a rapid rise. The price increased from 22cts per thousand cubic feet (mcf) in 1973 to $2.66/mcf in 1984. The rate of increase slowed in the latter years. Between 1973 and 1982, the price increased 1018%. This is an average annual increase of about 31%. The price moved up an additional 5.3% in 1983, and 2.7% in 1984. But then the wellhead price of natural gas began to fall dragging the rig count down even more. The wellhead price of natural gas fell 6.6% in 1985 to $2.51/mcf. And then in 1986 it fell another 25.5% to $1.87/mcf, and continued down into 1987.

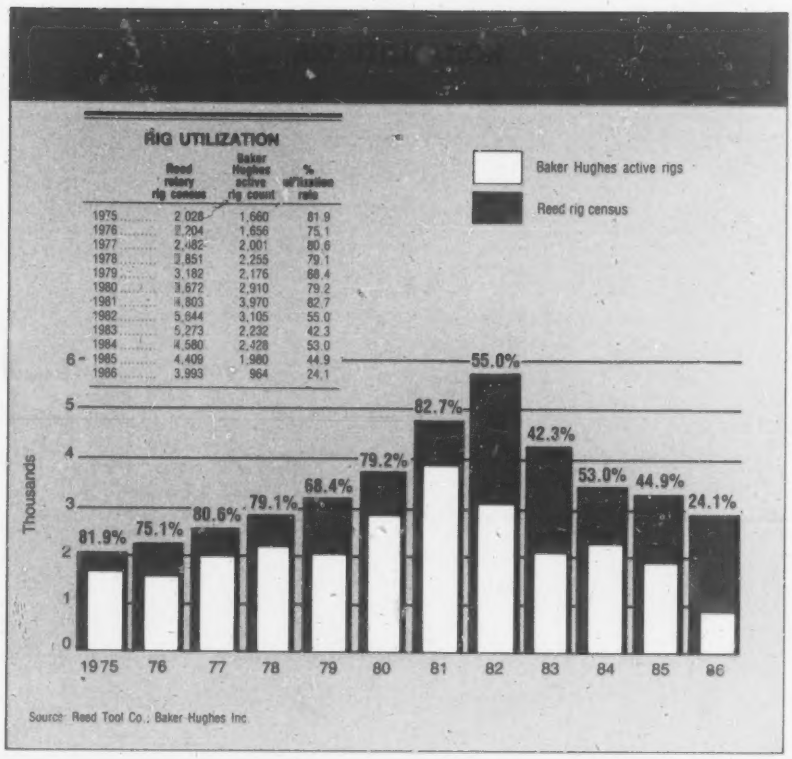
"The prices of crude oil and natural gas, along with the production, determine the level of wellhead realizations for reinvestment in exploration and drilling."

The prices of crude oil and natural gas, along with the production, determine the level of wellhead realizations for reinvestment in exploration and drilling. This pool of funds available from oil production, and the percentage reinvested, are the key determinants of drilling activity.

With rising oil and gas prices in the 1970's, total wellhead revenues moved up rapidly. Total wellhead realizations were $15,778 million in 1971. Total wellhead realizations peaked in 1981 at $138,947 million. This was the year of peak oil prices and a relatively high level of demand for natural gas. The windfall profit tax (WPT) took a portion of the revenues available in 1981. Net of this excise tax, total wellhed revenues, was $113,004 million. In addition to the high level of revenue available, the reinvestment ratio was the highest since 1970, at 32.4%. The reinvestment ratio is the percentage of total revenues available that are invested in drilling. Total drilling expenditures in 1981 were $36,665 million.

Total wellhead revenues available to the industry and the reinvestment ratio actually moved up still higher in 1982. Crude oil prices started to slide but were still high. Crude oil production moved up. Natural gas prices moved up in 1982. Total gross wellhead revenues slipped to $135,526 million but revenues net of the windfall profit tax moved up to $118,772 million. And the reinvestment ratio moved up to 33.2%. As a result total drilling expenditures moved up to a peak of $39,428 million.

As oil prices declined and natural gas demand fell, total wellhead realizations fell to $113,924 million in 1983, net of the WPT. In addition, the high debt that the industry had accumulated during the peak years had to be financed. This reduced the reinvestment ratio sharply to 22% in 1983. Drilling expenditures fell to $25,105 million. Total wellhead revenues moved up in 1984 to $123,174 million, net of WPT.



WELL COST AND OIL PRODUCTION

Year	Average cost per well ($)	Wellhead price of oil ($/bbl)	Barrels of oil to cover well cost
1970	94,885	3.18	29,838
1971	94,708	3.39	29,937
1972	106,424	3.39	31,394
1973	117,152	3.89	30,116
1974	138,718	6.74	20,581
1975	177,793	7.56	23,518
1976	191,615	8.19	23,396
1977	229,181	8.57	26,742
1978	279,950	9.00	31,106
1979	331,367	12.64	26,216
1980	367,682	21.59	17,030
1981	453,691	31.77	14,280
1982	514,378	28.52	18,036
1983	371,721	26.19	14,193
1984	326,463	25.88	12,614
1985	349,399	24.09	14,504
1986E	299,250	12.66	23,637

E-Estimate

Source: Department of Energy and API 1970-1985; Author's estimates 1986

TOTAL U.S. SUPPLY OF TUBULAR GOODS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Tubular goods (Thous. tons)											
Mill shipments	1,678	2,405	2,647	2,458	3,612	2,241	1,759	677	1,406	1,299	740
Less exports	169	140	155	285	133	128	67	8	12	14	12
Plus imports	219	487	591	457	1,036	2,389	2,180	565	2,214	1,506	918
U.S. supply	1,728	2,752	3,083	2,630	4,515	6,502	3,872	1,234	3,608	2,791	1,646
Footage drilled (Thous. ft.)	187,290	215,696	238,386	243,685	311,445	406,520	375,706	317,996	369,075	320,018	181,283
Tons tubular goods Per thous. ft	9.2	12.8	12.9	10.8	14.5	16.0	10.3	3.9	9.8	8.7	9.1

Source: IPAA, 1986 Author's estimates

Increased natural gas demand was the major reason for the increase. This was partially offset by lower crude oil prices. The reinvestment ratio fell to 20.5%. Total drilling outlays were an estimated $25,206 million in 1984. It should be noted that a portion of the drop in drilling expenditures in 1983 and 1984 was due to lower drilling costs. Therefore, the activity level did not drop as much as outlays.

In 1985, the wellhead revenues available to the industry fell to $118,048 million and the reinvestment ratio slid to 20.1%. Drilling outlays moved down to $23,697 million. With the collapse of prices in 1986 wellhead revenues fell to $69,192 million, about the same level as 1979. And the reinvestment ratio plummeted to 17%. Drilling expenditures fell to the lowest level since 1977, at an estimated $11,797 million.

DRILLING COSTS. The cost of drilling has fallen sharply since the peak of the drilling boom in 1981-1982. According to the Joint Association Survey of Drilling Costs, the average cost per well hit an all-time high of $514,378 in 1982. It fell sharply to $371,721 in 1983, a drop of 27.7%. The cost continued to slide in 1984, falling to $326,463, down 36.5% from the peak.

The sharp drop in well costs was primarily due to the competition in the market brought on by the excess capacity and inventory situation. Drilling contractors, as well as equipment and service companies, came away from the boom period with huge excess inventories and capacities. Prices were slashed in an effort to reduce inventories and use idle capacity. The costs moved up again slightly in 1985 to $349,399 per well. The increased well depth and the location of the wells probably had a lot to do with this cost increase.

RIG EFFICIENCY, WELLS DEEPER THAN 2,500 FT

Year	Rig count	Wells	Footage (Million)	Wells/ rig	Footage/ rig	Ft/well (Avg. depth)
1970	1,028	20,146	127.8	19.6	124,364	6,346
1971	976	18,226	116.4	18.7	119,260	6,386
1972	1,107	19,990	127.6	18.1	115,270	6,383
1973	1,194	20,464	129.1	17.1	108,120	6,309
1974	1,471	22,736	139.3	15.5	94,700	6,127
1975	1,660	27,140	164.4	16.3	99,040	6,057
1976	1,656	28,003	168.7	16.9	101,750	6,024
1977	2,001	32,803	196.8	16.4	98,350	5,999
1978	2,255	36,149	218.5	16.0	96,720	6,044
1979	2,176	36,096	221.1	16.5	101,560	6,125
1980	2,910	46,903	279.7	16.1	96,120	5,963
1981	3,970	62,009	368.8	15.6	92,800	5,948
1982	3,105	56,490	338.6	18.2	109,043	5,994
1983	2,232	48,357	280.7	21.7	125,775	5,805
1984	2,428	56,808	330.6	23.4	136,160	5,820
1985	1,980	47,815	285.3	24.1	144,091	5,967
1986	964	26,970	164.1	28.0	170,228	6,085

ROTARY RIGS RUNNING — BY STATES

Record high and low

State	Rig count 12-28-81	Rig count 7-14-86	Change 86-81	% change 86/81
Alabama-Land	20	3	-17	-85.0
Alabama-Offshore	3	2	-1	-33.3
Total Alabama	23	5	-18	-78.3
Alaska-Land	27	11	-16	-59.3
Alaska-Offshore	0	1	1	—
Total Alaska	27	12	-15	-55.6
Arkansas	42	7	-35	-83.3
California-Land	151	35	-116	-76.8
California-Offshore	25	2	-23	-92.0
Total California	176	37	-139	-79.0
Colorado	93	10	-83	-89.2
Florida-Land	4	1	-3	-75.0
Florida-Offshore	1	0	-1	-100.0
Total Florida	5	1	-4	-80.0
Georgia	0	1	1	—
Hawaii	1	0	-1	-100.0
Idaho	3	1	-2	-66.7
Illinois	105	5	-100	-95.2
Indiana	8	1	-7	-87.5
Kansas	214	33	-181	-84.6
Kentucky	15	3	-12	-80.0
N. Louisiana	54	8	-46	-85.2
S. Louisiana-Inl Water	87	13	-74	-85.1
S. Louisiana-Land	175	38	-137	-78.3
S. Louisiana-Offshore	168	44	-124	-73.8
Total Louisiana	484	103	-381	-78.7
Michigan	40	16	-24	-60.0
Mississippi	79	13	-66	-83.5
Montana	73	2	-71	-97.3
Nebraska	18	2	-16	-88.9
Nevada	2	2	0	—
New Mexico	160	11	-149	-93.1
New York	21	2	-19	-90.5
N. Dakota	123	10	-113	-91.9
Ohio	94	15	-79	-84.0
Oklahoma	871	99	-772	-88.6
Pennsylvania	38	15	-23	-60.5
Rhode Island—Offshore	3	0	-3	-100.0
S. Dakota	1	0	-1	-100.0
Tennessee	1	0	-1	-100.0
Texas-Offshore	78	15	-63	-80.8
Texas-Inl Water	0	1	1	—
District 1	38	4	-34	-89.5
District 2	122	11	-111	-91.0
District 3	220	22	-198	-90.0
District 4	133	26	-107	-80.5
District 5	32	9	-23	-71.9
District 6	144	18	-126	-87.5
District 7B	88	14	-74	-84.1
District 7C	99	9	-90	-90.9
District 8	206	30	-176	-85.4
District 8A	97	25	-72	-74.2
District 9	103	16	-87	-84.5
District 10	91	11	-80	-87.9
Total Texas	1,451	211	-1,240	-85.5
Utah	60	6	-54	-90.0
Virginia	3	6	3	100.0
Washington	3	0	-3	-100.0
W. Virginia	65	13	-52	-80.0
Wyoming	228	21	-207	-90.8
Total United States	**4,530**	**663**	**-3,867**	**-85.4**
Canada	262	68	-194	-74.0
Canada-Offshore	5	6	1	20.0
Grand Total	**4,797**	**737**	**-4,060**	**-84.6**

Source: Baker Hughes Inc.

ROTARY RIG ACTIVITY BY STATES

	Average rig activity										
	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976
Alabama	10.3	22.3	15.5	15.2	15.3	17.3	10.8	12.6	12.5	13	17
Alaska	12.8	20.2	14.1	13.8	21.6	23.5	13.8	13.5	15.5	15	14
Arizona	0.0	0.3	0.2	0.3	1.0	1.1	1.0	0.0	0.4	1	1
Arkansas	9.6	24.3	26.1	25.9	27.0	33.9	26.8	10.4	13.9	15	15
California	49.1	80.8	107.2	105.7	128.8	154.8	120.2	95.6	94.1	89	89
Inland	43.8	68.8	89.2	83.4	106.2	133.7	104.7	85.7	86.3	81	85
Offshore	5.3	12.0	18.0	22.3	22.6	21.1	15.5	9.9	7.8	8	4
Colorado	24.3	49.9	53.9	52.2	60.3	81.6	61.1	40.2	41.1	45	38
Florida	2.2	6.8	3.6	4.4	4.6	7.8	4.1	5.3	6.3	6	5
Idaho	1.0	1.3	0.8	1.2	1.5	3.2	2.6	1.8	3.2	1	1
Illinois	5.6	28.5	41.5	60.2	75.5	42.9	25.4	13.1	28.4	16	22
Indiana	1.2	3.7	6.6	5.9	7.1	1.2	0.1	0.3	4.4	3	2
Kansas	46.8	91.7	127.6	124.1	157.4	196.2	120.2	66.0	75.5	67	51
Kentucky	2.5	6.3	8.1	8.4	9.5	5.3	1.7	0.4	3.3	2	1
Louisiana	142.1	283.1	309.9	283.6	343.1	455.6	427.4	347.0	338.3	292	231
North	11.3	24.5	30.3	29.4	39.9	58.0	54.9	34.5	39.8	45	34
Inland waters	20.2	43.7	51.4	47.1	59.2	83.2	76.6	62.1	62.5	57	49
South	41.8	85.6	96.1	81.9	107.8	160.3	156.4	112.3	113.9	81	65
Offshore	68.8	129.3	132.3	125.2	136.2	154.1	139.4	138.1	122.1	109	83
Maryland	0.0	0	0.0	0.0	0.0	0.6	0.2	0.5	0.7	0	1
Michigan	24.0	34.0	34.1	29.1	31.4	36.5	30.7	25.1	24.0	24	24
Mississippi	15.3	31.0	32.4	32.8	41.6	71.5	57.6	40.2	44.5	42	32
Montana	9.7	22.8	36.0	23.9	36.2	81.4	49.2	32.9	30.1	27	28
Nebraska	3.1	6.5	9.1	9.0	9.4	15.0	14.3	9.2	9.6	9	8
Nevada	2.9	5.0	5.0	1.1	3.0	4.9	4.6	4.1	2.9	3	2
New Mexico	29.0	71.3	77.8	65.0	103.3	134.9	117.6	87.5	75.5	70	54
New York	2.2	5.2	8.9	10.2	15.1	11.6	7.0	8.7	7.0	6	9
North Dakota	13.3	38.9	50.9	42.5	69.4	118.8	83.4	56.5	39.1	24	19
Ohio	17.5	29.5	51.1	39.3	56.8	97.8	73.7	46.3	45.6	33	26
Oklahoma	141.2	251.0	319.2	285.5	621.5	698.4	397.3	246.7	258.2	233	186
Pennsylvania	17.9	30.2	35.5	22.0	32.5	38.6	29.0	28.9	25.2	15	10
Rhode Island offshore	0.0	0.0	0.0	0.0	2.4	2.0	2.1	4.0	4.3	1	0
South Dakota	0.6	1.7	2.2	1.0	1.5	2.2	1.9	1.4	2.3	3	2
Texas	310.9	679.8	850.1	797.5	989.6	1,317.0	987.7	770.2	855.0	799	653
Gulf Coast	44.5	102.1	138.1	133.9	169.0	305.2	210.5	141.3	197.0	175	160
Offshore & inland waters	21.7	52.1	60.1	56.2	88.3	74.5	72.1	50.3	46.9	42	36
North	36.5	82.7	99.6	125.0	138.1	170.7	147.2	122.4	153.2	142	111
Panhandle	16.0	37.4	49.9	48.3	66.2	66.6	50.8	48.1	60.4	42	37
East	45.4	77.0	102.1	102.2	115.7	163.9	119.8	107.0	116.6	73	54
West Central	41.7	87.1	124.5	102.7	139.8	191.6	140.4	109.4	117.2	136	101
West	105.1	241.3	276.9	229.2	272.5	344.5	247.1	191.7	163.7	169	154
Utah	11.1	28.8	45.3	36.8	39.8	69.2	42.4	28.9	32.1	30	19
W. Virginia	15.0	26.0	37.7	33.9	49.4	44.8	37.8	29.8	27.1	17	12
Wyoming	35.4	92.7	114.6	95.6	142.7	191.3	155.5	147.2	136.4	118	86
Others	6.9	5.5	3.2	5.0	6.5	8.6	3.3	2.9	2.0	2	0
Total U.S.	**963.5**	**1,980.0**	**2,428.2**	**2,232.3**	**3,104.9**	**3,969.5**	**2,910.3**	**2,177.2**	**2,258.8**	**2,001**	**1,658**
Canada	174.8	303.7	245.3	109.3	195.0	258.6	396.8	334.6	270.2	217	177
Canada offshore	4.1	9.3	13.7	10.4	5.4	4.8	4.7	4.1	1.5	1	2
Grand total	**1,142.5**	**2,293.0**	**2,687.2**	**2,433.0**	**3,305.3**	**4,232.9**	**3,311.8**	**2,515.9**	**2,530.5**	**2,219**	**1,837**

Source: Baker Hughes Inc. Note: Columns may not add due to independent rounding.

Preliminary indications are that the cost per well fell again sharply in 1986, as prices and drilling collapsed and competition in the drilling service and supply industry intensified. The estimated cost per well for 1986 is $299,250 down 14.4% from 1985, and 41.8% below the peak.

As stated, one of the reasons for the sharp drop in drilling costs was the intense competition in the industry due to the excess capacity. An indicator of excess capacity is the rig utilization rate. The size of the rig fleet moved up with oil prices, increasing from 1,767 rigs in 1973 to 5,644 rigs in 1982. Based on the annual average number of rotary rigs running, the rig utilization rate moved up from 52.5% in 1971 to 81.9% in 1975. The rate stayed in the 68% to 80% range from 1976-1980 and moved up to 82.7% in 1981.

The rig fleet was still growing in 1982 as rig activity was falling, and the utilization rate plummeted to 55%. The size of the rig fleet fell to 5,273 in 1983, but activity fell faster, and the utilization rate dropped to 42.3%. The total rig fleet fell to 4,580 in 1984, and the utilization rate moved up to 53%. In 1985, the rig fleet still stood at 4,409, but the number of active rigs fell to 1,980, resulting in a utilization rate of 44.9%. But the worst wasn't over and competition really intensified in 1986. The rig fleet fell to 3,993 but the rig count plummeted to only 964. This resulted in a utilization rate of only 24.1%. This extremely low utilization rate continues to put downward pressure on drilling costs.

With declining drilling costs offsetting the drop in oil prices, the economics of drilling activity improved slightly between 1982 and 1985. The cost of drilling and equipping a well in 1985 was down 32.1% from the peak. The average wellhead price of crude in 1985 was $24.09/bbl, down 24.2% from the peak. The profit margin improved, compared to the margin at the height of the drilling boom. However, that improvement was lost in 1986 when the wellhead price fell to $12.66/bbl. The 1986 price was down 60.2% from the peak while estimated well costs were down only 41.8% from the peak.

Another way of illustrating the economics is by comparing the volume of oil required to cover the average cost of a well. From 1970 to 1979, the number of barrels of oil that needed to be produced to cover the average cost of a well ranged from a low of 20,581 to a high of 31,394. This fell to 14,193 barrels in 1983, and only 12,614 in 1984, as well costs moved up in 1985, this went up to 14,504 barrels. When prices collapsed in 1986, the volume of oil required to cover well costs jumped to 23,637 barrels.

PRODUCING WELLS. With the surge in well completions the number of producing wells in the U.S. was moving up sharply. It reached an estimated 893,000 by year-end 1986. The higher oil and gas prices helped lengthen the life of old wells and slowed abandonments, in past years. But abandonments have accelerated recently at the lower prices.

The vast majority of U.S. operating wells are artificial lift wells. Over the period 1976-1984, the number of flowing wells has changed little. The number of flowing wells was 32,969 in 1976. This dropped to 31,927 in 1978 and then rebounded, moving up to 38,000 in 1981. At the end of 1986, it was estimated that there were 37,000 flowing wells. The number of artificial lift wells has increased

steadily from 470,299 in 1976 to 609,000 wells in 1985. The total number of oil wells was 646,000 at year-end 1986.

OUTLOOK

"The bad news is that drilling activity in the U.S. is at historically low levels. The good news is that it has hit bottom and activity is moving up."

The bad news is that drilling activity in the U.S. is at historically low levels. The good news is that it has hit bottom and activity is moving up.

Crude oil prices have moved up from the extremely low level of mid-1986 and are holding at a new plateau. And crude prices are expected to move up gradually over the forecast period. Natural gas prices are down considerably, but are expected to bottom out in 1987. But then natural gas prices are also expected to move up over the forecast period. The result of these expected increases in prices will be increasing domestic wellhead revenues over the forecast period. The increase from prices will be partially offset by declining crude production and sluggish natural gas production.

Total wellhead revenues in 1987 are estimated at $72,273 million. This is a slight 1.3% improvement over the low 1986 level. Although 1986 was the low year for wellhead revenues, 1987 will be the low for drilling expenditures. The reinvestment ratio will fall to 15.2% and drilling outlays are estimated at only $10,985 million down 6.9% from 1986. Uncertainty about prices particularly in the first half of the year, resulted in an extremely low level of investment and drilling activity. Although activity picked up in the second half, it was not enough to overcome the slow start. The number of active rigs for the year will set a record low in 1987 at an average 920. And well completions will slip to 38,640 with 180,060,000 feet drilled.

Higher prices and more confidence in relative price stability is expected to lead to an across-the-board improvement in all of these indicators in 1988. Total wellhead revenues will move up to $76,350 million on the strength of higher crude prices for the year. Some investment money will be restored and the reinvestment ratio will move up to 16.5%. The combination of higher cash flow from the wellhead and some renewed investor interest will boost drilling expenditures to $12,600 million in 1988. The number of active rotary rigs will jump up 15.2% to 1060 and well completions will be up to 44,210. Total footage drilled will increase to 207,790.

As the prices of crude oil and natural gas continue to increase throughout the remainder of the forecast period, 1988-1992, the activity level will continue to rise. The increases will be modest by boom period standards, but there will be a measurable improvement from 1980-1987 level.

The driving forces will be the increased cash flow through improved wellhead revenues and an increase in the reinvestment ratio. Wellhead revenues are projected to increase to $97,300 million by 1992, up $25,027 million. In addition increased profitability, resolutions of debt problems left over from the boom and an influx of more outside money, will boost the reinvestment ratio to 21% by 1992.

The combination of higher wellhead revenues and an increased reinvestment ratio will result in substantially higher drilling expenditures. Total drilling outlays are expected to move up 85.7% by 1992 to $20,400 million.

The average number of active rotary rigs is not expected to increase as rapidly. It will move up to 1520 in 1992, an

increase of 65.2%. Well completions are projected to increase 57.6% to 60,890 in 1992. And footage drilled is expected to increase 61.3% to 290 million feet.

These indicators will not increase as rapidly as total spending because there will be an increase in average well costs and a shift to deeper well drilling. Average well costs are expected to increase 17.8% by 1992 to $335,000/well. This will be somewhat less than the projected increase in crude prices or the rate of increase in general inflation. The excess capacity in the service and supply industry is expected to hold down large price increases, particularly early in the forecast period. If well costs move up faster, it could have a negative impact on drilling activity.

The absolute number of deeper wells is expected to increase over the forecast period with renewed exploration activity and increased natural gas drilling. There will be a steady search for more economically attractive reservoirs and less shallow development drilling with a less profitable reserve base. The result will be a steady increase in the average well depth. It is expected to increase 2.4% to 4770 feet by 1992.

"Higher prices and more confidence in relative price stability is expected to lead to an across-the-board improvement in all of these indicators in 1988."

This increase in well depth combined with the increased number of wells will push annual footage drilled up substantially. It will be up 110 million feet per year by 1992 to 290 million feet.

The rough measures of drilling rotary rig efficiency are expected to decline over the forecast period. But it will be caused by the shift to deeper wells and more exploratory work rather than any real drop in efficiency. These wells take longer to complete. The number of wells drilled per active rotary rig will peak in 1987 at 42. It will slide down to 40.1 wells per rig in 1992. Footage per rig is projected to move up slightly in 1988 to 196,030. Following that it wil turn down and slip to 191,080 in 1992.

The economics of oil well drilling are expected to improve over the forecast period. Prices are expected to move up faster than well costs over this period. The number of barrels of oil needed to cover the average well cost shot up to 23,640 in 1986. It is estimated to have fallen to 19,150 in 1987. Over the forecast period a continued improvement is expected. It will fall to 17,540 barrels in 1988, 15,850 in 1990 and 15,230 in 1992.

Well abandonments are not expected to be as great as was anticipated a year ago. Producers have been able to cut operating costs and keep wells alive longer than anticipated. With prices up fewer wells will be plugged. Abandonments will be less in the years 1988 through 1992, than they were in 1986 and 1987. The total number of producing wells will steadily increase as well completions outnumber abandonments. Total producing wells will aproach 1 million, reaching 980,000 by the end of the forecast period.

THE OUTLOOK—EXPLORATION, DRILLING, PRODUCTION

	1986	1987	1988	1989	1990	1991	1992	Change 1987 to 1992	% change 1987 to 1992
DRILLING ACTIVITY:									
Active rotary rigs	964	920	1,060	1,135	1,320	1,450	1,520	600	+65.2
Well completions	39,423	38,640	44,210	46,780	53,800	58,560	60,890	22,250	+57.6
Footage drilled (thousands)	181,283	180,060	207,790	220,330	253,940	277,570	290,440	110,380	+61.3
Av. well depth	4,598	4,660	4,700	4,710	4,720	4,740	4,770	110	+ 2.4
Wells drilled per active rig	40.9	42.0	41.7	41.2	40.8	40.4	40.1	-1.9	- 4.5
Footage drilled per active rig	188,053	195,720	196,030	194,120	192,380	191,430	191,080	-4,640	- 2.4
REVENUE AND COST:									
Av. well cost ($)	299,250	284,290	285,000	295,000	305,000	320,000	335,000	50,710	+17.8
Total wellhead revenues ($ million)	71,542	72,273	76,350	78,830	86,360	93,710	97,300	25,027	+34.6
Total drilling expenditures ($ million)	11,797	10,985	12,600	13,860	16,410	18,740	20,400	9,415	+85.7
% of revenue invested in drilling	16.5	15.2	16.5	17.5	19.0	20.0	21.0	+5.8	+38.2
PRODUCTION:									
Capital expenditures ($ million)	2,995	2,586	3,060	3,240	3,860	4,580	4,870	2,284	+88.3
Producing wells (Dec 31st)	893,000	888,150	900,000	920,000	940,000	960,000	980,000	91,850	+10.3
Abandoned wells	23,821	32,900	18,000	14,500	17,700	21,000	22,600	-10,300	-31.3

KEYS TO THE FUTURE

1. Increased crude oil and natural gas prices will boost total wellhead revenues substantially over the 1988-1992 period.

2. The economics of drilling will improve as revenues move up faster than drilling costs.

3. The reinvestment ratio will improve as revenues move up faster than drilling costs.

4. Additional investment will result in a 65% increase in the rig count. The average number of active rigs will reach 1520 by 1992.

5. Well completions will increase substantially rising to over 60,000 by 1992.

Refining and Petrochemicals

THE CYCLES IN THE REFINING INDUSTRY have not been as volatile as in the exploration and drilling sector. But the U.S. and worldwide refining industry has also been going through a prolonged period of adjustment caused by the rapid change in oil prices.

Making significant changes in the refining industry requires far longer lead times. To add refining capacity requires considerable lead time for planning and construction. To add facilities for additional processing to handle heavier more sour crudes, requires considerable lead time for planning and construction. To add facilities for additional processing to produce a greater percentage of light products requires considerable lead time for planning and construction. Any additions tend to be quite costly and therefore careful analysis is required before making a committment.

When demand was on the rise through the 1950's, 1960's and 1970's, planning consisted of carefully timing new added capacity to meet expected needs. The expansion phase in the refining sector continued beyond the peak period for demand. The initial downturn in demand was thought to be only temporary. And in addition, some new facilities were already under construction.

So before the downturn was felt in the upstream segment of the business, it was being detected in the refining sector. With demand falling and refining capacity on the rise, a large excess refining capacity developed in the U.S. and worldwide. With excess refining capacity, refining margins and profits fell sharply. While earnings from exploration, drilling and production activities were substantial, the refining sector was experiencing a period of sparse earnings and even losses for some operations.

Finally realizing what had happened, and to resolve the financial problems refiners began to reduce capacity. Although the relative percentage changes are not as large as the shifts in exploration and drilling activity, this change was possibly even more significant. The refining industry had not been through a cycle before where overall capacity had to be reduced to a new perception of demand. What was now significantly different was the fact that for the first time long-range expectations were for lower demand.

So refining capacity continued to be reduced to try to close the gap between capacity and demand. The objective was to boost the utilization rate, reduce unit costs, improve margins and increase profitability. And financial conditions in the industry did improve. In 1985-86, the refining sector received a financial boost when a number of OPEC countries, led by Saudi Arabia, adopted netback pricing. At the same time, the market was flooded with available crude oil and crude costs plummeted.

The combination of lower crude costs and netback pricing boosted refining margins substantially for a short period. Lower crude costs meant lower refinery feedstock costs. And crude costs fell faster than product costs. And for many refiners netback contracts virtually locked in a profit margin for every barrel of crude purchased and processed.

But with the OPEC adoption of

REFINERY CAPACITY AND UTILIZATION

	Number of plants*			Total capacity†	Crude runs	Utilization rate	Excess capacity
	Operating	Shut-down	Total	(1,000 b/d)	(1,000 b/d)	(%)	(1,000 b/d)
1973	253	28	281	13,671.4	12,431	90.9	1,240.4
1974	257	27	284	14,361.5	12,133	84.5	2,228.5
1975	262	28	290	14,960.7	12,442	83.2	2,518.7
1976	265	22	287	15,236.6	13,416	88.1	1,820.6
1977	273	18	291	16,398.4	14,605	89.1	1,793.4
1978	290	12	302	17,047.7	14,739	86.5	2,308.7
1979	301	10	311	17,440.9	14,646	84.0	2,794.9
1980	311	8	319	17,988-1	13,482	74.9	4,506.1
1981	315	9	324	18,620.5	12,471	67.0	6,149.5
1982	254	47	301	17,889.7	11,774	65.8	6,115.7
1983	233	25	258	16,859.3	11,685	69.3	5,174.3
1984	214	33	247	16,137.1	12,044	74.6	4,093.1
1985	199	24	223	15,658.8	12,002	76.6	3,656.8
1986	192	24	216	15,458.9	12,716	82.3	2,742.9

*As of January 1. †As of January 1. Includes operating and operable shutdown.

Source: Energy Information Administration, American Petroleum Institute

REFINERY CASH OPERATING MARGINS

Gulf Coast average (dollars per barrel)

Year	Margins
1975	0.47
1976	0.26
1977	0.60
1978	0.53
1979	1.47
1980	1.55
1981	0.30
1982	1.05
1983	0.03
1984	0.72
1985	0.16
1986	0.03

Source: Wright Killen & Co.

REFINERY RUNS BY DISTRICTS

	Crude runs, 1,000 b/d									
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
East Coast	1,496	1,537	1,478	1,296	1,202	1,103	960	1,019	1,061	1,122
Appalachian Dist. 1	178	180	167	158	132	93	77	87	92	101
Total Dist. 1	1,674	1,717	1,645	1,454	1,334	1,196	1,037	1,106	1,153	1,223
Appalachian Dist. 2	65	60	65	51	54	51	53	58	60	54
Ill., Ind., Ky.	2,406	2,425	2,353	2,063	1,803	1,714	1,798	1,784	1,777	1,847
Minn., Wisc., Dak.	267	279	294	238	229	251	253	282	285	294
Okla., Kan., Mo.	1,040	1,044	1,017	943	883	763	642	636	617	627
Total Dist. 2	3,778	3,808	3,729	3,295	2,969	2,779	2,746	2,760	2,739	2,822
Texas:										
Inland	477	476	472	445	469	456	474	499	472	472
Gulf Coast	3,442	3,524	3,462	3,142	2,829	2,726	2,801	2,780	2,750	2,990
Louisiana Gulf	2,158	2,140	2,167	2,085	2,030	1,941	1,862	2,012	1,972	2,162
N. La., Ark.	196	214	200	186	163	162	170	177	168	170
New Mexico	87	84	89	86	81	77	75	68	60	63
Total Dist. 3	6,360	6,438	6,390	5,944	5,572	5,362	5,382	5,536	5,422	5,857
Total Dist. 4	469	488	477	442	425	416	420	436	432	431
Total Dist. 5	2,324	2,288	2,405	2,347	2,171	2,021	2,100	2,206	2,256	2,383
Total U.S.	14,605	14,739	14,646	13,482	12,471	11,774	11,685	12,044	12,002	12,716

Source: Energy Information Administration

new production quotas and a tightening of the market, crude prices moved back up. Netback pricing was scrapped by the crude producers. Refining margins disappeared. Conditions had changed again in the refining sector.

REVIEW

"Although refining capacity continued to increase through 1981, demand had peaked in 1978."

CAPACITY. Demand for petroleum products in the U.S. increased 8.9%, from 17.308 million b/d in 1973 to 18.847 million b/d in 1978. Over this period, United States refining capacity moved up from 13.7 million b/d in 1973 to 18.6 million b/d in 1981, an increase of 4.9 million b/d or 36.2%. During that period, capacity was expanding to meet increasing actual demand and to meet expected future demand. The number of plants operating increased from 253 in 1973 to 315 in 1981. Total plants moved up from 281 to 324. The number of available plants shut down was reduced from 28 in 1973 to 9 in 1981.

Although refining capacity continued to increase through 1981, demand had peaked in 1978. The refining industry in 1980 and 1981 was still operating under the guidance of a long-term outlook that foresaw increasing demand. Demand for petroleum products in the U.S. fell for 5 consecutive years in response to the massive price increases of mid- and late-1970s. Demand fell 3.616 million b/d, 19.2%, to 15.231 million b/d in 1983; as stated refining capacity continued to increase through 1981. But crude runs peaked in 1979 along with demand for petroleum products. Subsequently, the utilization rate, which was as high as 90.9% in 1973, and averaged 86.6% from 1973 to 1979, dropped to 75% in 1980. As demand continued to fall, the rate dropped to extremely unprofitable levels of utilization below 70%: 67% in 1981, 65.8% in 1982 and 69.3% in 1983. Excess capacity ranged from 1.2 million b/d to 2.8 million b/d between 1973 and 1979. This jumped up to 4.5 million b/d in 1980 and 6.1 million b/d in 1981 and 1982.

"The refining industry had historically operated in an atmosphere of ever-expanding refining capacity in response to demand for products."

The drop in demand resulted in a change in the perception of the longer-range trend in product demand, and there was a substantial change in the long-range forecasts of petroleum product demand. Expectations of increases parelleling the long-range growth in economic activity of 3- 4%/year were put to rest. Refiners realized that the lower demand levels experienced were not a temporary phenomenon, and they realized that they could not simply wait for demand to return. The refining industry realized that a capacity adjustment to lower demand levels was required. Capacity would have to be reduced in order to increase the utilization rate, cut unit costs, and improve margins.

From the peak in 1981, average total distillation capacity moved down 17% to 15.5 million b/d in 1986. This was a capacity cut of 3.162 million b/d. The number of plants operating fell from 315 in 1981 to 192 in 1986, a drop of 123, and the number of total plants is down from 324 to 223, off 101. There are now 24 plants temporarily shut down. Many plants have been closed permanently.

The refining industry had historically operated in an atmosphere of ever-

expanding refining capacity in response to demand for products. Adjusting their planning process to accommodate a shrinking industry was difficult. But a leaner, more efficient industry was essential if refinery margins were to improve. Operable capacity actually moved up slightly in 1987. At mid-year, capacity had moved up to 15.690 million b/d, and the average utilization rate was around 81%. Refiners prefer a rate of 85-90%, and increased demand may boost the utilization rate to this level in the future. Therefore, there is not expected to be any drop in overall capacity. But further adjustments to refining capacity will depend upon the refiners' expectations of future demand for petroleum products.

"Spending is expected to remain relatively high in the future to meet changing product demand patterns and to meet changing crude qualities. With crude costs up and very competitive products markets, it is unlikely that margins will improve greatly in the near future."

Even with the excess capacity situation, capital expenditures for refining facilities remained relatively high over the 1981-1985 period. A substantial portion of this was for upgrading capacity to handle cheaper, but heavier, crude and investment to enable production of a greater yield of lighter products. As overall distillation capacity was falling, upgrading capacity was increasing.

Illustrative of the shift to a greater demand for lighter products is the shift in resid and gasoline. In 1977, resid demand represented 16.7% of the demand barrel, and gasoline 38.9%. By 1985, this had shifted to resid only 7.6% and gasoline, 43.4%. There was a slight reversal in this trend in 1986 as resid moved up to 8.7% and gasoline dropped to 43.2%. Whether resid continues to decline as a percentage of the overall barrel will depend on the ability to compete with other fuels for the utility and heavy industry markets.

Capital spending for refining facilities moved up rapidly between 1978 and 1982 increasing from $1,551 million to $5,775 million. Over the next four years, during the downturn refining fell steadily to an estimated $2,073 million in 1986.

Spending is expected to remain relatively high in the future to meet changing product demand patterns and to meet changing crude qualities. The ability to handle the heavier crude and upgrade the output so as to produce a greater yield of lighter products is essential for long-term profitability in the refining industry. Even though resid demand is expected to increase, over the long term, lighter products will be the most profitable for refiners.

MARGINS. The problems refiners face can best be seen in looking at the value of the refined barrel compared to the cost of crude and refining costs. The total value of the refined barrel went from $14.73 in 1977, prior to the second large price hike, to $39.07 in 1981. The refiners acquisition cost of crude moved up from $11.96 in 1977 to $35.24 in 1981. Between 1977 and 1981, the net value to the refiner after subtracting refining costs was generally positive, averaging about $0.89/bbl. However, rapidly rising crude oil costs, coupled with rising refining costs, as the utilization rate fell, turned net margins negative. Margins have fluctuated over the past few years, but falling product sales and high unit costs due to the low capacity utilization rate kept margins generally low or negative.

Refining cash operating margins

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turned positive in 1985 with lower crude costs, and margins have remained positive in 1986 with netback contracts, much lower crude costs and high utilization rates. However, the operating margins in 1986 were not significantly above break even. And as crude costs moved up in 1987, operating margins again turned negative. With crude costs up and very competitive products markets, it is unlikely that margins will improve greatly in the near future.

Another factor that may have an impact is the expansion of OPEC's refining capacity. This will introduce more products into the worldwide market and intensify competition.

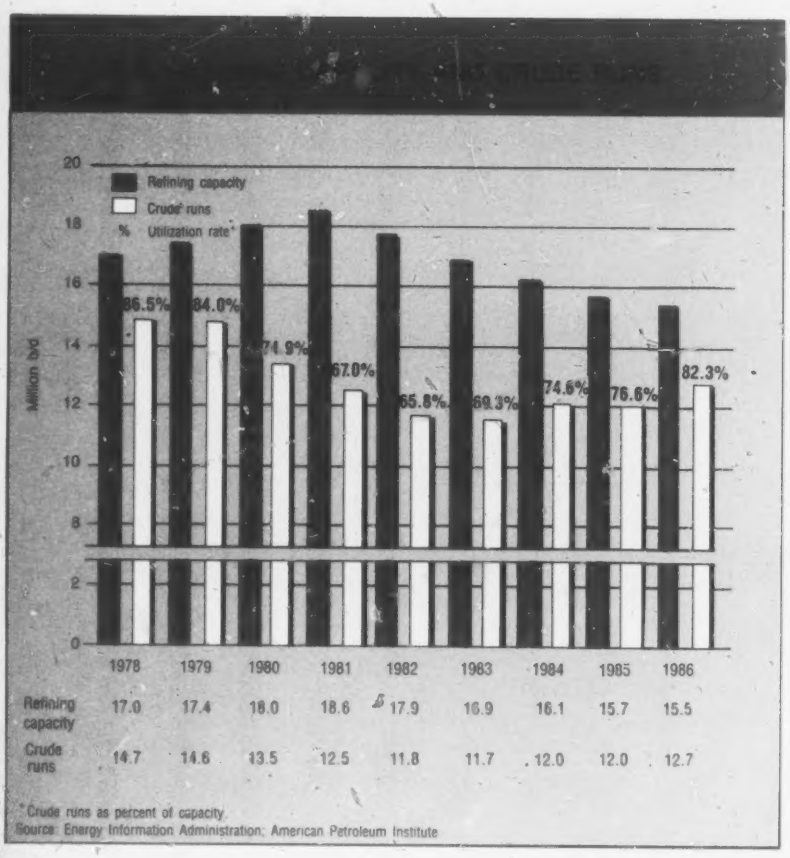
PETROCHEMICALS. The chemical/petrochemical industry activity closely follows the growth pattern of the overall economy. But it is also affected by the price cycles of crude oil and other hydrocarbons that are used as petrochemical feedstocks. When crude costs were on the rise, it had a huge impact on the feedstock costs of the petrochemicals industry, and a great impact on margins and profitability. It also forced an excess capacity situation as worldwide capacity additions have exceeded demand. It should be noted that additional capacity has been added recently in the Middle East aggrevating this situation.

After experiencing steady growth in shipments from 1975 through 1981, the industry slipped a bit in 1982. Higher prices resulting from using feedstock costs and slower growth in economic activity reduced demand for petrochemicals. But the industry rebounded in 1983, and growth continued in 1984 and 1985.

According to the Chemical Manufacturers Association, the value of total U.S. chemical shipments increased 2.9% in 1985 to $217.4 billion. Shipments in 1984 were $211.31 billion, up 11.7% from 1983. Shipments in 1983 were up 9.5%, following a drop of 4.3% in 1982.

The increase in the value of shipments in 1985 was mainly due to a slight increase in prices. Production volumes were at the same level as 1984, while prices moved up 0.7%. The operating rate increased to 78.2% in 1985, from 72.3% in 1984. The rate had fallen to 66% in 1982. The shutdown of a number of plants helped boost the overall utilization rate of remaining capacity.

Preliminary data indicates that demand and production were up about 5% in 1986 and this growth rate is continuing in 1987. Demand for petrochemicals has been increasing in recent years, but overcapacity and competition from energy-rich countries had a negative impact on margins. As feedstock costs and other operating costs increased, they became a greater percentage of total costs. The margins were reduced, and with overcapacity worldwide there was substantial competition. But with these reduced operating margins, price cutting was no longer an effective competitive tool. Volumes could not be increased to make up for the loss of revenue. The situation improved somewhat in 1986 and 1987. Lower crude prices reduced feedstock costs and boosted margins. And increased demand increased the utilization rate, lowered unit costs and also boosted margins.



The key to future profitability for the industry is still increasing efficiency while keeping capacity under control.

"Total U.S. demand for petroleum products is expected to move up 7.1% over the forecast period, to 17.53 million b/d in 1992."

OUTLOOK

THE U.S. REFINING INDUSTRY has come through a period dominated by excess capacity and low margins and the outlook is good.

Total U.S. demand for petroleum products is expected to move up 7.1% over the forecast period, to 17.53 million b/d in 1992."

Total U.S. refining capacity, which was slimmed down due to the lower demand levels, is projected to be on the increase over the 1987-1992 period. Total U.S. refining distillation capacity is expected to be increased 3.1% to 16.1 million b/d in 1992.

Refinery crude runs and total input to distillation units is expected to also increase. Crude runs will move up 8.8% to 13.85 million b/d and inputs to distillation units will increase to 13.99 million b/d. Most of the increase in demand will be met by increased domestic crude runs. Product imports are expected to move up only marginally over the forecast period, increasing only 100,000 b/d by 1992. As a result, the refinery utilization rate will move up to more profitable levels. The utilization rate will increase steadily over the next five years and is projected to increase to 86.9% in 1992.

Capital spending in the refining industry is projected to move up through the forecast period. The increased outlays will be for the added capacity modernization and increased upgrading capacity. Refiners still are planning to be able to handle heavier crude in future years. And it is still expected that it will be more profitable to have a higher yield of lighter products.

A recent study showed that it is expected that world crude oil will continue to get heavier and have a greater sulfur content. The API weight of crude processed by U.S. refiners will move from about 32.6 at present to 31.8 in 1985 and 31.1 in 1990. The average sulfur content will go from about 0.96% to 1.07% in 1985 and

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1.18% in 1990. Newly proposed environmental rules limiting the sulfur and aromatics content of diesel fuels could also result in increased investment for new facilities.

Refiners will not have the luxury of netback deals to insure improved margins during the forecast period. But increased demand for light products should increase revenues and higher utilization rates should cut unit operating costs. So if demand stays strong, as anticipated, margins should improve.

The future for the petrochemical industry also appears favorable. Demand is expected to grow at an annual rate of 4-5%. And if capacity does not expand excessively, the utilization rate should remain high and margins stay strong.

Capital spending by the U.S. oil companies on petrochemical facilities is expected to increase 24.3% over the forecast period to $1,700 million in 1992. The U.S. industry is facing stiff competition worldwide due to the addition of new export facilities in the Middle East. These facilities have very low feedstock costs and in some cases government subsidies. Saudi Arabia has stated that their goal is to obtain a larger share of the petrochemical market. This has resulted in some petrochemical producers to plan to move away from the feedstock-intensive commodities business and shift towards the higher value-added specialty products markets.

THE OUTLOOK — REFINING & PETROCHEMICALS

	1986	1987	1988	1989	1990	1991	1992	Change 1987 to 1992	% change 1987 to 1992
U.S. domestic demand (thousand barrels/day)	16,281	16,370	16,520	16,640	16,970	17,270	17,530	1,160	+ 7.1
U.S. refining capacity (thousand barrels/day)	15,494	15,620	15,700	15,800	15,900	16,000	16,100	480	+ 3.1
Crude runs (thousand barrels/day)	12,716	12,730	12,970	13,080	13,370	13,630	13,850	1,120	+ 8.8
Input to distillation units (thousand barrels/day)	12,833	12,850	13,090	13,200	13,500	13,760	13,990	1,140	+ 8.9
Refinery utilization rate (%)	82.8	82.3	83.4	83.5	84.9	86.0	86.9	4.6	+ 5.6
Product imports (thousand barrels/day)	2,045	1,900	1,900	1,920	1,940	1,980	2,000	100	+ 5.3
Product imports % of domestic demand	12.6	11.6	11.5	11.5	11.4	11.5	11.4	0.2	- 1.7
CAPITAL SPENDING: ($ million)									
Refining	2,073	2,280	2,370	2,450	2,560	2,680	2,750	470	+20.6
Petrochemical	1,357	1,368	1,450	1,520	1,610	1,670	1,700	332	+24.3
PRICES:									
Refinery acquisition cost ($/barrel)									
Domestic	14.83	17.15	18.60	19.90	21.70	23.50	24.50	7.35	+42.9
Imported	13.98	17.45	18.90	20.20	22.10	23.90	25.00	7.55	+43.3
Composite	14.55	17.25	18.70	20.00	21.90	23.70	24.70	7.45	+43.2
Motor gasoline ($/gallon)	0.931	0.995	1.100	1.150	1.200	1.250	1.300	0.305	+30.7
Distillate fuel oil (Home heating) ($/gallon)	0.844	0.905	1.000	1.055	1.110	1.165	1.210	0.305	+33.7

REFINING AND PETROCHEMICALS

KEYS TO THE FUTURE

1. U.S. domestic demand for petroleum products will increase 7.1% by 1992.

2. U.S. refining capacity will move up only 3.1%, to 16.1 million b/d in 1992.

3. Increased crude runs to meet demand will boost the utilization rate to a more profitable 86.9% by the end of the forecast period.

4. Product imports will only move up marginally since U.S. excess refining capacity can be used to meet increased demand.

5. Capital spending on refining and petrochemicals will increase over the 1987-1992 period. Higher prices and demand will increase industry revenues.

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Transportation

OVER THE PAST TEN YEARS, there has been a substantial change in the level and location of production and demand in the U.S. oil and gas industry.

Demand for petroleum products declined 3.616 million b/d between 1978 and 1982. And even though domestic demand has increased over the past five years, in 1987 it was still down 2.477 million b/d from the peak.

Domestic marketed production of natural gas and domestic consumption of natural gas have also declined during this period. Domestic marketed production fell 17.9% from 20.5 trillion cubic feet in 1979 to 16.8 trillion cubic feet in 1986. Consumption during that same period fell 20.9% to 16 trillion cubic feet in 1986.

In addition, over this time, domestic production of crude oil went through several transitions from declining production, to increasing production, to the present period of declining production.

All of these shifts have combined into a substantial negative impact on activity and investment in the transportation sector of the industry. This has been true for the U.S. and also to a degree for the worldwide transport industry.

There had been a general decline in the volume of crude oil, products and natural gas in transport in the U.S.. Worldwide there was a general decline in the volume of crude oil transported and this resulted in a substantial decline in the size of the international transport fleet. Although there was a shift in 1986, the level of transport activity was still down substantially from the peak periods.

As a result, there has been a general decline in capital expenditures for pipelines and other transport over the past several years.

The level of activity in the transport sector is related to both the volume and location of the crude, products or natural gas to be moved. The location of both production and consumption are continually changing. Therefore, distribution patterns are constantly changing. And this can and does result in a continuing level of new investment in the transport sector. Shifting distribution and transport patterns change transport needs even if volumes are not increasing. This is true for all aspects of transport, pipelines, water going vessels, trains and vehicles.

REVIEW

U.S. PETROLEUM TRANSPORT. The total ton miles of crude oil and petroleum products carried in U.S. domestic transportation moved up steadily from 1972 through 1980. It increased 48.5% from 838.8 billion ton miles to a peak of 1,245.3 billion ton miles in 1980.

It declined slowly between 1980 and 1983, but then dropped rather sharply to 1,180.2 billion ton miles in 1984, down 5.2% from the peak. It moved up slightly to 1,195.5 billion ton miles in 1985, due to an increase in crude oil transport.

Crude oil transported constituted 60.5% of the total in 1980. It had moved up slightly to 65.8% in 1985. This shift was probably due to the decline in domestic demand for petroleum products and the increase in domestic crude oil production. For

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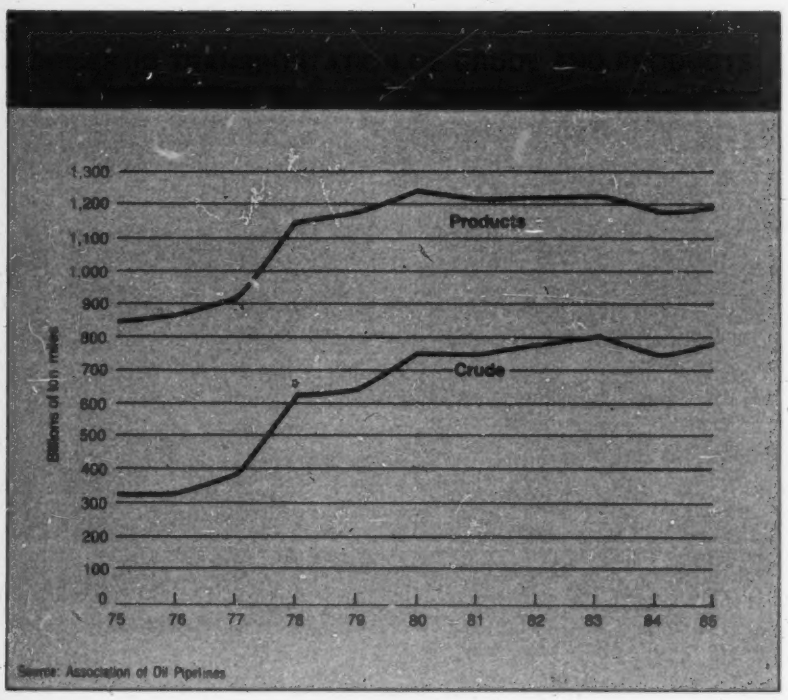

crude oil carried in domestic transport, pipelines and water carriers accounted for 99.7% of total ton miles moved. This has not changed much over the past fifteen years. Motor carriers and railroads carry a very small portion of crude oil moved.

"Since the peak of transport of petroleum products in 1978, the pipeline volume has decreased slightly and the percentage has moved up considerably."

Movement of crude oil has followed a different pattern than that for overall crude and petroleum products. Transport of crude oil moved up to a peak of 806.1 billion ton miles in 1983. It dropped to 748.4 billion ton miles in 1984 and then moved up to 786.2 billion in 1985.

There has been a shift in crude transport from pipelines to water carriers. In 1977 pipelines carried 83.2% of the crude and water carriers 16.1%. Due to the increased volumes of crude moved long distances by water from Alaska, this shifted to 57.7% pipline and 41.9% water carrier in 1978. In 1985, this had moved to 42.5% pipeline and 57.2% water carrier. The total volume carried by pipelines also fell. It was at a peak of 372.2 billion ton miles in 1979. In 1985, it was down to 334.4 billion ton miles. Water carrier volume hit a peak of 471.2 billion ton miles in 1983. It was 449.2 ton miles in 1985.

Total ton miles of petroleum products carried in domestic transport peaked in 1978, at 536.7 billion ton miles. That was the year of peak domestic demand. This had moved down to 409.3 billion ton miles in 1985, down 23.7%. Pipelines and water carriers accounted for 90.7% of the transport in 1985. Motor carriers accounted for 6.6% and railroads, 2.7%. Much of the short haul and smaller volumes are carried by motor carriers. Motor carriers and railroads also service areas where pipelines and water carriers do not or can not provide service.

Since the peak of transport of petroleum products in 1978, the pipeline volume has decreased slightly and the percentage has moved up considerably. The total pipeline volume was 236.1 billion ton miles in 1979. It dipped to 223.7 billion in 1983, and then bounced back to 235.1 billion in 1984 and 229.9 billion in 1985. The relative volume increased from 44.2% in 1979 to 56.2% in 1985.

The water carrier volume peaked in 1977 at 270.2 billion ton miles of petroleum products. It had fallen to 141.2 billion ton miles in 1985. The

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TOTAL CRUDE PETROLEUM AND PETROLEUM PRODUCTS CARRIED IN DOMESTIC TRANSPORTATION

By mode of transportation
(Billions of ton miles)

Year	Total crude and products Ton miles	PIPELINES Ton miles	PIPELINES Percent of total	WATER CARRIERS Ton miles	WATER CARRIERS Percent of total	MOTOR CARRIERS* Ton miles	MOTOR CARRIERS* Percent of total	RAILROADS Ton miles	RAILROADS Percent of total
1972	838.8	475.8	56.73	330.0	39.34	23.0	2.74	10.0	1.19
1973	843.6	507.0	60.10	296.8	35.18	25.0	2.96	14.8	1.76
1974	847.7	506.0	59.69	297.0	35.04	29.0	3.42	15.7	1.85
1975	846.7	507.0	59.88	298.0	35.20	27.6	3.26	14.1	1.66
1976	867.7	515.0	59.35	306.9	35.37	32.5	3.75	13.3	1.53
1977	923.4	546.0	59.13	333.3	36.09	29.6	3.21	14.5	1.57
1978	1,160.2	585.8	50.49	530.6	45.73	30.6	2.64	13.2	1.14
1979	1,174.8	608.3	51.78	522.9	44.51	30.1	2.56	13.5	1.15
1980	1,245.3	588.2	47.24	617.8	49.61	26.8	2.15	12.5	1.00
1981	1,218.4	563.7	46.27	617.2	50.66	24.9	2.04	12.6	1.03
1982	1,218.2	565.7	46.44	616.9	50.64	22.7	1.86	12.9	1.06
1983	1,223.5	556.1	45.45	630.5	51.53	25.1	2.05	11.8	.97
1984	1,180.2	568.1	48.14	570.7	48.36	29.2	2.47	12.2	1.03
1985	1,195.5	564.3	47.20	590.4	49.39	28.7	2.40	12.1	1.01

TOTAL CRUDE PETROLEUM CARRIED IN DOMESTIC TRANSPORTATION

By mode of transportation
(Billions of ton miles)

Year	Total crude Ton miles	PIPELINES Ton miles	PIPELINES Percent of total	WATER CARRIERS Ton miles	WATER CARRIERS Percent of total	MOTOR CARRIERS* Ton miles	MOTOR CARRIERS* Percent of total	RAILROADS Ton miles	RAILROADS Percent of total
1972	362.0	284.5	78.6	76.0	21.0	1.0	0.3	0.5	0.1
1973	363.2	302.0	83.1	58.8	16.1	1.3	0.4	1.1	0.4
1974	358.9	303.0	84.4	53.0	14.3	1.3	0.4	1.6	0.4
1975	331.5	288.0	86.9	40.6	12.2	1.4	0.4	1.5	0.5
1976	343.8	303.0	88.1	37.8	11.0	2.1	0.6	0.9	0.3
1977	392.5	326.6	83.2	63.1	16.1	2.0	0.5	0.8	0.2
1978	623.5	359.5	57.7	261.3	41.9	2.0	0.3	0.7	0.1
1979	640.6	372.2	58.1	265.5	41.4	2.3	0.4	0.6	0.1
1980	753.0	362.6	48.2	387.4	51.4	2.5	0.3	0.5	0.1
1981	740.7	333.1	45.0	404.9	54.6	2.2	0.3	0.5	0.1
1982	770.2	335.1	43.5	432.7	56.2	2.0	0.2	0.4	0.1
1983	806.1	332.4	41.2	471.2	58.5	2.0	0.2	0.5	0.1
1984	748.4	333.0	44.5	412.6	55.1	2.2	0.3	0.6	0.1
1985	786.2	334.4	42.5	449.2	57.2	1.8	0.2	0.8	0.1

TOTAL PETROLEUM PRODUCTS CARRIED IN DOMESTIC TRANSPORTATION

By mode of transportation
(Billions of ton miles)

Year	Total petroleum products Ton miles	PIPELINES Ton miles	PIPELINES Percent of total	WATER CARRIERS Ton miles	WATER CARRIERS Percent of total	MOTOR CARRIERS* Ton miles	MOTOR CARRIERS* Percent of total	RAILROADS Ton miles	RAILROADS Percent of total
1972	476.8	191.3	40.1	254.0	53.3	22.0	4.6	9.5	2.0
1973	480.4	205.0	42.7	238.0	49.5	23.7	4.9	13.7	2.9
1974	488.8	203.0	41.5	244.0	49.9	27.7	5.7	14.1	2.9
1975	515.2	219.0	42.5	257.4	50.0	26.2	5.1	12.6	2.4
1976	523.9	212.0	40.5	269.1	51.4	30.4	5.8	12.4	2.3
1977	530.9	219.4	41.3	270.2	50.9	27.6	5.2	13.7	2.6
1978	536.7	226.3	42.2	269.3	50.2	28.6	5.3	12.5	2.3
1979	534.2	236.1	44.2	257.4	48.2	27.8	5.2	12.9	2.4
1980	492.3	225.6	45.8	230.4	46.8	24.3	5.0	12.0	2.4
1981	477.7	230.6	48.3	212.3	44.4	22.7	4.8	12.1	2.5
1982	448.0	230.6	51.5	184.2	41.1	20.7	4.6	12.5	2.8
1983	417.4	223.7	53.6	159.3	38.2	23.1	5.5	11.3	2.7
1984	431.8	235.1	54.4	158.1	36.6	27.0	6.3	11.6	2.7
1985	409.3	229.9	56.2	141.2	34.5	26.9	6.6	11.3	2.7

*Estimate

Source: Association of Oil Pipelines

PIPELINE CONSTRUCTION—1987 AND BEYOND*

Area	†4-10 in.	12-20 in.	22-30 in.	Larger than 30 in.	Total
			Miles		
GAS PIPELINES					
U.S.	1,819	1,320	3,092	3,383	9,614
Canada	1,540	171	521	1,328	3,560
Latin America	1,054	746	2,174	107	4,081
Asia-Pacific	505	559	589	615	2,268
Western Europe	1,759	2,146	3,171	2,913	9,989
Middle East	4	150	3	496	653
Africa	451	70	74	559	1,154
Total gas	**7,132**	**5,162**	**9,624**	**9,401**	**31,319**
CRUDE PIPELINES					
U.S.	249	97	832	1,055	2,233
Canada	186	678	—	1,435	2,299
Latin America	30	893	—	543	1,466
Asia-Pacific	40	29	70	—	139
Western Europe	3	41	—	—	44
Middle East	3	75	335	2,040	2,453
Africa	302	25	150	—	477
Total crude	**813**	**1,838**	**1,387**	**5,073**	**9,111**
PRODUCT PIPELINES					
U.S.	1,110	970	—	20	2,100
Canada	—	145	—	—	145
Latin America	619	903	—	—	1,522
Asia-Pacific	128	49	—	—	177
Western Europe	66	65	—	—	131
Middle East	388	41	—	—	429
Africa	263	—	—	—	263
Total products	**2,574**	**2,173**	**—**	**20**	**4,767**
NON-COMMUNIST WORLD TOTALS					
Gas	7,132	5,162	9,624	9,401	31,319
Crude	813	1,838	1,387	5,073	9,111
Product	2,574	2,173	—	20	4,767
Total	**10,519**	**9,173**	**11,011**	**14,494**	**45,197**

*Projects planned and under way †Includes some projects of less than 4 in.

Source: Oil & Gas Journal

reduction of the import of residual fuel oil from U.S. Caribbean Island refineries was a major factor in this decline. The percentage carried by water carriers fell from 50.9% in 1977 to 34.5% in 1985.

Almost all natural gas is transported by pipeline. The change in overall domestic production and consumption are the major factors determining the activity level for natural gas movement and pipleline construction. The importation of natural gas from neighboring countries can also be a factor. Changes in the volume and location of these imports can also be a factor in pipeline volume and location.

PIPELINES. Between 1973 and 1982, total U.S. pipeline mileage increased from 419,464 miles to 459,548 miles. This was an increase of 40,084 miles, 9.6%. Gas pipeline mileage increased from 248,773 miles to 286,999 miles, an increase of 38,226 miles. The increase in gas pipelines accounted for 95.4% of the increase in total pipeline mileage. Liquids pipeline mileage was 172,549 miles in 1982, up

OIL/WORLD TANKER FLEET, BY SIZE

(Million DWT)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1986 Share of total	% change 86/76
10-25,000 dwt	17.5	16.1	14.8	14.2	14.1	13.8	13.5	13.0	12.8	12.3	12.4	5.2	-29.1
25-45,000 dwt	27.3	26.6	24.6	24.2	24.6	26.0	27.2	27.4	26.3	25.8	26.3	10.9	-3.7
45-65,000 dwt	19.9	18.2	16.1	15.3	16.1	16.6	16.1	15.3	15.7	15.0	14.2	5.9	-28.6
65-125,000 dwt	54.4	54.2	50.8	51.2	52.5	55.4	51.8	48.4	46.2	44.4	46.6	19.3	-14.3
125-200,000 dwt	28.7	32.3	33.3	33.4	33.0	31.2	30.2	28.8	28.9	28.4	27.5	11.4	-4.2
200-320,000 dwt	144.8	156.6	157.4	157.7	155.4	146.5	134.5	120.4	111.6	94.9	90.6	37.6	-37.4
320,000 dwt and over	28.1	28.5	31.5	31.9	29.1	30.7	30.4	29.9	28.2	26.0	23.4	9.7	-16.7
Total World	320.7	332.5	328.5	327.9	324.8	320.2	303.7	283.2	269.7	246.8	241.0	100.0	-24.9

Source: British Petroleum

only 1.1% from 170,691 miles in 1973. The change in total mileage does not reflect all total new construction. Some old pipelines are shut down each year so that new construction represents more than net additions.

Total interstate pipeline mileage in the U.S. peaked in 1982 at 459,548 miles. That was also the year of peak natural gas pipeline mileage of 286,999 miles, 62.5% of total mileage. Liquids pipeline mileage was 172,549 miles that year. Since that time total mileage has fallen, mainly because of a drop in gas pipeline mileage. The latest year for which data is available is 1985. In that year total mileage was 450,796 miles, down 8,752 miles from the peak. Gas pipeline mileage fell to 279,395 miles down 7,604 miles. Liquids pipeline mileage was 171,401 miles, down 1,148 miles from 1982. The peak year for liquids pipeline mileage was 1976, with 174,072 miles.

These figures can also be a bit misleading with respect to pipeline construction activity. Even though total mileage has been declining, there has been ongoing construction activity. New discoveries and changing distribution patterns require an everchanging pipeline network. Pipelines are added to new or expanding producing areas, and are shut down as areas are depleted. Population growth and shifts require new distribution pipelines.

The level of expenditures on new pipeline construction activities is quite significant. Pipeline expenditures are representation of the industry's perception of future long-term needs. Most pipeline projects are of a long duration and do not have an impact on immediate needs. Therefore, the relative level of spending is a good leading indicator of the expected changes in the level of activity in the oil and gas industry.

CAPITAL SPENDING. Industry capital expenditures for transportation are spread over natural gas pipelines, crude oil pipelines, petroleum product pipelines, water transport vessels, railroad cars and motor carriers. The vast majority of the spending is for pipeline construction.

Capital spending on total U.S. pipeline construction increased from $672 million in 1972 to $7,390 million in 1982, an increase of 999.7% over the ten years. Spending on natural gas pipelines increased from $578 million in 1972 to $6,070 million in 1982, 950.2%. Crude and product pipeline outlays in 1982 were $1,320 million, up 1,304.3% from $94 million in 1972. Outlays for crude and product pipelines have been more volatile, reaching a peak of $2,949 million in 1976 when the Alaskan pipeline was under construction. More recently, spending reached $2,456 million in 1983.

But pipeline spending outlays have been coming down in recent years, for both crude and product pipelines and natural gas pipelines. Spending fell to $1,744 million in 1986 down 76.4% from 1982. Of the 1986 total, $1,309 million was for natural gas pipelines and $435 million for crude and products pipelines. Natural gas pipeline spending was down 78.4% from the 1982 level.

Pipeline construction plans for 1987 indicate a slight rebound in expenditures. Total pipeline spending is planned

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at $2,289 million, up 31.3%. Natural gas pipeline outlays are planned at $1,556 million up 18.9%. Crude and product pipelines are planned at $733 million, up $298 million.

Ocean-going tankers for the transportation of crude also represent huge investments. But in the recent market, with substantially reduced demand, and therefore reduced import/export volumes, there was a massive surplus of tanker tonnage.

"The worldwide tanker industry has been severely depressed in recent years as crude and products trade dropped sharply from the peak of 1978-1979."

The domestic industry also uses water carriers for a substantial proportion of crude oil and product transport. But with reduced domestic demand, transport volumes have moderated in recent years, and this has reduced the need for additional investment.

Investment for other land transport and inland water transport represents smaller outlays and is less volatile. A reduction in expenditures due to lower demand has been offset somewhat by increased expenditures due to changing patterns of distribution. Capital expenditures on other modes of transport also moved up rapidly, increasing from $175 million in 1972 to $895 million in 1981, up 411.4%. Outlays started to fall in 1982 and dropped to $380 million in 1986. This was a decline of 57.5%. Plans for 1987 for the U.S. industry are for outlays of $361 million down another 5%.

TANKERS. Some of these outlays had been for ocean-going tankers for crude transport. When imports fell sharply, this had a negative impact on the tanker industry.

The worldwide tanker industry has been severely depressed in recent years as crude and products trade dropped sharply from the peak of 1978-1979. The tanker fleet fell from the peak of 332.5 million deadweight tons in 1977 to 241 million tons in 1986. This was a drop of 27.5%. Much of the existing tonnage is idle or under-utilized.

The adjustment took the shape of eliminating redundant VLCC tankers. They are used mainly for long-distance transport, and the long-haul volumes of crude from the Persian Gulf to the United States were cut sharply. The industry is now concentrating on smaller and more flexible tankers. To hold down losses, many excess tankers have been converted for other uses, such as offshore storage.

The development of the North Sea oil fields also had a substantial impact on the tanker industry. As these fields developed, Europe was transformed from long-haul tanker trade to short-haul. In the early and mid-1970's, Europe relied primarily on long-haul oil from the Persian Gulf. This oil moved in VLCC tankers through the Straits of Hormuz and around the Cape of Good Hope. With the North Sea fields, many of these tankers were no longer needed. The tonnage scrapped moved up from 7.7 million tons in 1980 to 26.5 million tons in 1985, an increase of 18.8 million tons. Trade volumes picked up in 1986 and this slowed scrappage and the rate of reduction in the fleet size.

Trade movements increased 8.9% in 1986 to 26.265 million b/d. This was up 2.145 million b/d but still down from the peak of 35.35 million b/d in 1979. But as a result the tonnage scrapped fell to 13 million tons and the size of the world fleet fell only 5.8

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million tons.

The picture may be changing for the tanker fleet as petroleum demand and imports increase, particularly in the U.S. United States import requirements appeared to be the real key to improvement in tanker needs. But profitability in the tanker industry will also depend on scrappage rates, which would reduce the overall size of the fleet and increase average utilization rates. There is still substantial excess capacity to be absorbed in the tanker industry.

OUTLOOK

SIGNIFICANT CHANGES ARE EXPECTED OVER THE FORECAST PERIOD in a number of the factors that have an impact on the transport sector of the industry. Changes are occurring both in the U.S. and worldwide industry.

"The picture may be changing for the tanker fleet as petroleum demand and imports increase, particularly in the U.S."

U.S. petroleum product demand is projected to increase requiring the movement of greater volumes of petroleum products. U.S. crude production is on the decline reducing the volume of transport of domestic crude. But import volumes will increase requiring more long-range transport of crude. Natural gas production and consumption are expected to start moving up significantly toward the end of the forecast period. And spurred by increasing U.S. import needs, the worldwide trade in crude and petroleum products is expected to increase in volume over the forecast period.

All of these changes are reflected in the projected increase in transport capital expenditures over the 1987-1992 period.

The latest survey of pipeline construction plans, by the ***Oil & Gas Journal***, shows plans for an additional 13,947 miles of pipeline to be constructed in the U.S. in 1987 and the years beyond. Natural gas pipelines represent 9,614 miles of the planned new construction, 68.9% of the total. New crude oil pipeline construction plans are for 2,233 miles, 16.0%. And product pipelines will add 2,100 miles, 15.1% of the total.

Although U.S. pipeline construction has fallen from the boom levels of 1981-1983, it is obvious that a substantial level of new construction is planned. The pipeline industry has also been required to adjust to changing expectations for the industry and changing requirements for pipeline transport. But demand for natural gas and crude oil are expected to increase during the forecast period and that will require additional pipelines.

Total U.S. capital expenditures for new pipeline construction are expected to increase 20.1% over the forecast period to $2,750 million in 1992. This is an increase of $461 million. Outlays for gas pipeline will increase 18.9%, up $294 million to $1,850 million in 1992. Crude and product pipeline construction will increase 22.8%, up $167 million to $900 million in 1992. Increased exploration and drilling activity, increased demand for petroleum products, and increased imports will all have an impact on supply patterns and therefore on pipeline construction.

U.S. capital expenditures for other transport needed by the industry will also be affected by increased activity and demand. But the majority of the

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outlays will be for replacement of existing transport. Capital spending for other transport is projected to increase 13.6% to $410 million in 1992. Non-communist world crude production is expected to move up 9.1% over the forecast period. And the location of some of the production will be changing. This will require increased crude transport.

According to the ***Oil & Gas Journal*** survey, worldwide non-communist pipeline plans are for a total of 45,197 miles for 1987 and the following years. A total of 31,250 miles will be outside the U.S.

The growing worldwide importance of the natural gas industry is reflected by the 31,319 miles of new gas pipeline planned. Outside the U.S. plans are for 21,705 miles.

A total of 9,111 miles of new crude pipeline is expected, with 6,878 miles outside the U.S.. Total product pipeline mileage planned is 4,767 miles with 2,667 miles outside the U.S.

Europe leads the way on plans for gas pipeline construction with 9,989 miles. The Middle East is the leader for crude pipelines with 2,453 miles planned.

The U.S. leads the way for product pipelines with 2,100 miles planned. Latin America is next with 1,522 miles of product pipeline planned. Latin America is also planning 4,081 miles of gas pipeline and 1,466 miles of crude pipeline.

The world petroleum trade is expected to increase 19.5% to 29.91 million b/d by 1992. This might call for investment in additional tankers. Particularly if the war in the Persian Gulf continues to target tankers and help reduce the fleet size.

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THE OUTLOOK — TRANSPORTATION

	1986	1987	1988	1989	1990	1991	1992	Change 1987 to 1992	% change 1987 to 1992
CAPITAL SPENDING ($ million)									
Gas pipelines	1,309	1,556	1,610	1,650	1,710	1,800	1,850	294	+18.9
Crude and product pipelines	435	733	750	840	870	900	900	167	+22.8
Other transport	380	361	370	400	400	410	410	49	+13.6
Total transportation	**2,124**	**2,650**	**2,730**	**2,890**	**2,980**	**3,110**	**3,160**	**510**	**+19.2**
WORLD PETROLEUM TRADE (thousand barrels/day)	26,265	25,035	25,900	26,600	27,600	28,800	29,910	4,875	+19.5

KEYS TO THE FUTURE

1. U.S. demand for petroleum products and natural gas will move up over the 1987-1992 period, boosting transport requirements.

2. To meet this increased transport need, capital spending will increase close to 20% by 1992.

3. Worldwide petroleum trade will increase steadily as demand increases. Increased U.S. imports will have a major impact on worldwide transport needs.

Natural Gas

THE NATURAL GAS SECTOR OF THE INDUSTRY is still lagging in its adjustment to the volatile price changes that have marked the energy business over the past ten to fifteen years. And by lagging in the adjustment, it has lost market share and volume in the present extremely competitive energy market.

Prices and demand for energy have exhibited a great deal of volatility over the recent past. And structural changes, such as multifuel capacity and conservation programs have increased the level of competition in the energy business. Faced with substantial volatility and increased competition, companies have to be able to adjust rapidly to current conditions if they are to retain market share.

Government regulation of the natural gas industry has been the major impediment to its ability to adjust to changing conditions and compete effectively. Government controls and regulations distort the economics and interfere with the market mechanism. Government price controls do not allow for a sufficient self-correcting mechanism that would enable rapid movement to equilibrium at a market clearing price.

"Government regulation of the natural gas industry has been the major impediment to its ability to adjust to changing conditions and compete effectively."

The long-term contractual arrangements that were, in the past, an integral part of the industry trading operation also proved to be a problem area when rapid price adjustment was required. These factors have prevented the natural gas industry from rapidly and effectively eliminating its major present problem, the "gas bubble." The gas bubble is a large excess of gas deliverability compared to present demand. The gas bubble developed because changes occurred more rapidly than the industry was able to adjust.

Prior to the hikes in crude oil and energy costs, demand for natural gas usually moved up or down with movements in the level of economic activity. Natural gas was priced so that it held an advantage over competing fuels in certain areas and markets. This enabled natural gas to maintain a base demand load, while it attempted to expand into other areas and markets.

Natural gas prices followed other energy prices and moved up slowly in the early 1970's. As other energy prices moved up more rapidly, natural gas prices followed. Higher natural gas prices stimulated exploration and drilling for natural gas, and deliverability increased. At the same time, higher prices led to conservation and increased competition from competing fuels.

Although other energy prices such as crude oil started falling in 1981, natural gas prices continued to move up until 1984. At higher prices natural gas faced even greater competition. Natural gas lost some base load to conservation and still more to other fuels due to the change in relative prices.

The result was the development of a substantial "gas bubble" with available deliverable supply much greater than demand. The duration of the gas bubble is difficult to predict. Natural gas now finds itself in a very competitive energy market. In order to try to retain markets, the natural gas industry will have to become more aggressive in marketing as well as adjusting prices to meet the competition from other fuels. One thing that could help greatly would be the removal of excessive government

UNITED STATES NATURAL GAS SUPPLY AND DEMAND

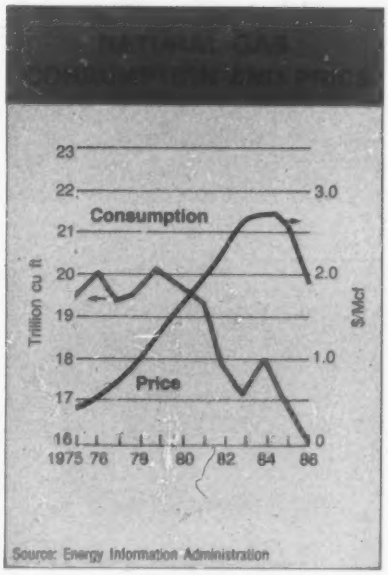
	1975	1980	1983	1984	1985	1986
	Billion cu ft					
Marketed production	20,109	20,180	16,822	18,230	17,198	16,809
Supplemental gas	0	155	132	110	126	142
Imports	953	985	920	843	949	754
Losses (including extraction)	(1,107)	(1,417)	(1,432)	(980)	(1,170)	(1,526)
Total supply	**19,955**	**19,903**	**16,442**	**18,203**	**17,103**	**16,179**
Exports	73	49	55	55	57	55
Stock change	344	(23)	(448)	197)	(235)	121
Domestic demand	**19,538**	**19,877**	**16,835**	**17,951**	**17,281**	**16,003**
	Sector demand (Trillion BTU)					
Residential & commercial	7,581	7,540	7,025	7,293	7,085	6,968
Industrial	8,532	8,394	6,823	7,449	7,086	6,366
Transportation	595	650	505	545	520	495
Electric utility	3,240	3,810	2,999	3,220	3,160	2,702
Total	**19,948**	**20,394**	**17,352**	**18,507**	**17,851**	**16,531**

Source: Energy Information Administration

NATURAL GAS PROCESSING AND LIQUIDS PRODUCTION

	Billion cu ft			Natural gas liquids	
	Gross gas production	Gas processed	Percent processed	Gallons per Mcf of gas processed	Liquids produced (000 b/d)
1970	23,786	18,509	77.8	1.376	1,661
1971	24,088	19,252	79.9	1.348	1,693
1972	24,016	19,906	82.9	1.347	1,744
1973	24,067	19,679	81.8	1.353	1,737
1974	22,849	18,684	81.8	1.386	1,689
1975	21,103	17,748	84.1	1.410	1,632
1976	20,944	17,718	84.6	1.388	1,604
1977	21,097	17,570	83.2	1.400	1,618
1978	21,308	17,012	79.8	1.381	1,567
1979	21,883	16,400	75.0	1.481	1,585
1980	21,870	15,750	72.0	1.537	1,576
1981	21,597	14,817	68.6	1.664	1,609
1982	20,210	14,164	70.1	1.678	1,550
1983	18,597	13,173	70.8	1.814	1,559
1984	20,192	13,946	69.1	1.792	1,630
1985	19,534	14,145	72.4	1.744	1,609
1986	18,919	13,620	72.0	1.746	1,551

Source: Oil & Gas Journal and EIA



Source: Energy Information Administration

U.S. GAS PRODUCTION AND RESERVES

	1973	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	% change 86/73
	(Billion cu ft)													
Marketed production														
Texas	8,514	7,486	7,192	7,051	6,548	7,175	7,116	6,910	6,469	5,939	6,185	6,053	6,092	-28.4
Louisiana	8,242	7,090	7,007	7,215	7,476	7,266	6,940	6,780	6,172	5,332	5,825	5,013	4,889	-40.7
Others	5,891	5,532	5,754	5,759	5,950	6,030	6,124	6,266	5,879	5,551	6,220	6,132	5,828	-1.1
Total U.S.	**22,648**	**20,109**	**19,952**	**20,025**	**19,974**	**20,471**	**20,180**	**19,956**	**18,520**	**16,822**	**18,230**	**17,198**	**16,809**	**-25.8**
	(Billion cu ft)													
Reserves														
Total U.S.	249,950	228,200	216,026	208,878	200,302	194,917	199,021	201,730	201,512	200,247	197,463	193,369	185,400	-25.8
	(Years)													
Reserves/production ratio														
Total U.S.	11.04	11.35	10.83	10.43	10.03	9.52	9.86	10.11	10.88	11.90	10.83	11.24	11.03	

Source: American Petroleum Institute; Energy Information Administration

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MARKETED PRODUCTION OF NATURAL GAS BY STATES*

State	1980	1981	1982	1983	1984	1985	1986
				(Billion cu ft)			
Alabama	65.3	79.2	75.0	90.8	101.8	107.3	107.2
Alaska	230.6	242.6	264.4	276.7	289.1	321.3	306.5
Arkansas	111.8	93.0	124.6	127.6	135.2	155.1	132.5
California	309.4	380.4	384.0	415.3	476.3	491.3	469.4
Colorado	188.0	195.7	209.9	163.5	173.3	178.2	158.5
Florida	40.6	32.5	22.5	21.1	12.6	10.5	8.9
Kansas	735.0	640.1	429.6	434.7	466.0	512.9	448.3
Louisiana	6,939.9	6,780.2	6,171.6	5,332.1	5,825.1	5,013.7	4,888.5
Michigan	158.3	152.6	153.1	138.9	144.5	131.9	127.0
Mississippi	175.1	181.2	167.2	151.2	157.9	144.2	142.7
Montana	51.9	56.6	56.5	52.0	51.5	52.5	49.5
New Mexico	1,148.1	1,132.1	991.2	895.3	957.4	905.3	709.9
North Dakota	42.3	42.6	53.8	69.3	70.5	72.6	59.6
Oklahoma	1,891.8	2,019.2	1,934.4	1,730.1	1,985.9	1,936.3	1,917.5
Texas	7,115.9	6,910.0	6,468.8	5,938.6	6,185.0	6,052.6	6,092.1
Utah	87.8	91.2	94.3	63.2	74.7	83.4	88.1
W. Virginia	156.6	161.3	150.9	130.1	143.7	144.9	130.1
Wyoming	407.1	408.4	424.7	444.0	516.7	416.6	495.5
Others	324.3	357.2	343.4	347.8	462.4	467.4	477.0
Total	20,179.7	19,955.8	18,519.7	16,822.1	18,229.6	17,198.0	16,808.8
Volume change	-292	-224	-1,436	-1,698	1,407	-1,032	-389.2
Percent change	-1.4	-1.1	-7.2	-9.2	8.4	-5.7	-2.3

*Includes nonhydrocarbon gases.

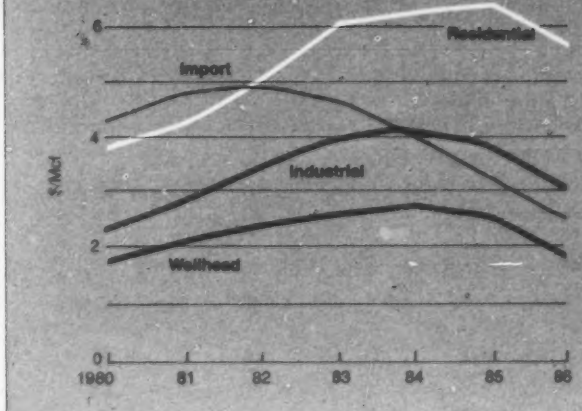
Source: Energy Information Administration

PRODUCTION, IMPORTS

	Total marketed prod.	Imports	Total new supply*	Imports % total supply
	(Billion cu ft)			
1973	22,648	1,033	23,681	4.4
1974	21,601	959	22,560	4.3
1975	20,109	953	21,062	4.5
1976	19,952	964	20,916	4.6
1977	20,025	1,011	21,036	4.8
1978	19,974	966	20,940	4.6
1979	20,471	1,253	21,724	5.8
1980	20,180	985	21,165	4.7
1981	19,956	904	20,860	4.3
1982	18,520	933	19,453	4.8
1983	16,822	920	17,742	5.2
1984	18,230	843	19,073	4.4
1985	17,198	949	18,147	5.2
1986	16,809	754	17,563	4.3

*Before losses.

Source: Energy Information Administration



Source: Energy Information Administration

NATURAL GAS PRICES

	1980	1981	1982	1983	1984	1985	1986
				$/1,000 cu ft			
Wellhead price	1.59	1.98	2.46	2.59	2.66	2.51	1.87
Import price	4.42	4.84	4.94	4.51	4.08	3.18	2.51
Industrial sales price	2.56	3.14	3.87	4.18	4.22	3.95	3.18
Residential price	3.68	4.29	5.17	6.06	6.12	6.12	5.62

controls. Returning natural gas to a more market-oriented structure would lead quickly to a stronger, more efficient industry.

REVIEW

PRICES. As in other sectors of the industry, prices have been one of the most important factors affecting the natural gas sector over the past fifteen years.

Over the ten-year period 1973-1982, the average wellhead price of natural gas went up 1,118.2% from $0.22/mcf in 1973 to $2.46/mcf in 1982. That is an average annual increase of 30.8%. Over this period, the relationship between crude oil and natural gas prices changed. Relative to the cost of crude oil, the cost of natural gas increased about 50% over this period and natural gas lost some competitive advantage.

Natural gas demand began to fall in 1981 and 1982. But even in the face of falling demand throughout 1981 and 1982, prices continued to move up relentlessly. Long-term contracts entered into when the accepted outlook was for a natural gas shortage, continued to push up prices. Because of the take-or-pay provisions in most contracts, it became advantageous for the pipelines purchasing gas to continue to take high-priced gas and curtail acceptance of the lower-priced gas when demand began to fall. This aggravated the situation and drove up the price.

Even though prices for crude oil were falling and demand for natural gas was declining prices of natural gas continued to move up in 1983 and 1984. But price increases were somewhat more moderate during 1983 and 1984. The average wellhead price moved up 5.3% in 1983 to $2.59/mcf, and up a modest 2.7% in 1984 to $2.66/mcf. Over the entire span 1974 to the peak year of 1984, the price increased $2.44/mcf.

Over the same period, the price paid by electric plants increased $3.37/mcf from $0.35/mcf in 1973 to $3.72/mcf in 1984. The residential price moved up $4.77/mcf from $1.29/mcf in 1973 to $6.06/mcf in 1984.

The price paid by electric utilities moved up 963%, and the residential price moved up 369.8% over the 1973-1984 period. This led to a great deal of conservation and fuel switching. Faced with that rate of increase in natural gas energy costs, an effort was made by all consumers to conserve.

In response to the falling prices of competing fuels and declining natural gas demand, natural gas prices started to fall in 1985. The price decline accelerated in 1986 and into 1987. But again in 1986, the natural gas industry could not react quickly enough to the sharp drop in crude oil prices, and additional demand was lost. In mid-1986, for the first time, the price paid by steam electric utility plants for heavy oil fell below natural gas. The price per million BTU for heavy oil fell below natural gas in April 1986 and remained lower through October 1986. The price per million BTU for heavy oil fell as low as $1.841 in July 1986. Natural gas in July was $2.161 per million BTU.

As a result of this change in price relationships, natural gas lost market share in the utility sector in 1986. Also

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putting downward pressure on gas prices recently has been an increase in gas to gas competition. Gas distributors are competing with each other for the same customers. This has the affect of lowering gas prices without substantially increasing demand for natural gas.

CONSUMPTION. Consumption of natural gas fell from 22.05 trillion cu. ft. in 1973 to 16.84 trillion cu. ft. in 1983, a drop of 23.6%. It rebounded to 17.95 trillion cu. ft. in 1984, an increase of 6.6% from the previous year. It dropped slightly to 17.28 trillion cu. ft. in 1985. It then fell sharply to 16 trillion cu. ft. in 1986.

"Natural gas has held a cost advantage over heating oil in the residential market, and a cost advantage over residual fuel oil in the utility and industrial sectors."

Natural gas has held a cost advantage over heating oil in the residential market, and a cost advantage over residual fuel oil in the utility and industrial sectors. By 1982 a substantial portion of this cost advantage had eroded and natural gas was meeting competition it had not experienced before. In the residential sector, conversions from home heating oil to natural gas slowed. And in the industrial and utilities sectors, natural gas fell victim to the recession and to competition from other fuels. The Fuel Use Act also contributed to the problem. These regulations gave utilities and heavy industry low priority in the case of a supply curtailment. Without supply assurances utilities and industry sought other fuels. The Fuel Use Act also restricted expansion of gas generation facilities.

In addition, utilities and industry has been moving toward installing multiple fuel capabilities so they can take advantage of any price differentials between fuels. This may also become prevalent for residential and commercial heating in future years. This has resulted in natural gas meeting very intense competition in many of its markets. In order to compete, prices had to adjust. In the face of growing competition, natural gas prices peaked in 1984 and started to move down. But natural gas consumption continued to slide, falling to 17.281 trillion cubic feet in 1985 and down to 16 trillion cubic feet in 1986. And demand in early 1987 is down from 1986 and not showing a great deal of strength.

PRODUCTION. Marketed production of natural gas in the U.S. followed demand, falling from 22,648 billion cu. ft. in 1973 to 16,822 billion cu. ft. in 1983, down 25.7%. Production moved up in 1984 to 18,230 billion cu. ft., an increase of 8.4%. However, production fell again in 1985, down 5.7% to 17,198 billion cu. ft.. And domestic production continued this downward movement falling to 16,809 billion cu. ft. in 1986. This was the lowest level of domestic marketed production since 1965.

There was no concern about the availability of natural gas over this period. The higher gas prices stimulated the supply side for natural gas. Exploration and production activity moved up sharply during the drilling boom year 1979-1982.

The number of gas wells completed moved up from 3,983 in 1971 to 19,742 in 1981 and 18,363 in 1982. And the number of completions has remained relatively high over the 1983-1984 period. Gas well completions

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"Over the forecast period, natural gas is expected to face a great deal of competition from competing fuels."

dropped to 14,619 in 1983, then moved up to 17,201 in 1984. But gas well drilling has slipped in recent years falling to 12,875 in 1985 and an estimated 7,599 in 1986.

With high production rates and little development natural gas reserves fell between 1973 and 1979. Natural gas reserves fell sharply from 249,950 billion cu. ft. in 1973 to 194,917 billion cu. ft. in 1979, down 22%. The reserves-production rate fell from 11.04 years in 1973 to 9.52 years in 1979.

However, with the increased exploration and drilling activity, reserves have been sustained and actually increased slightly between 1979 and 1984. With the decline in drilling, reserves have begun to fall again, dropping to an estimated 185,400 billion cu. ft. in 1986. But because of the drop in production, the reserves production ratio was still 11.03 years. This drop in reserves, however, may have a significant impact on future deliverability and may signal the elimination of the gas bubble.

There has been some concern expressed about the impact of natural gas imports on domestic production. However, there does not appear to be any upward trend in gas imports. From 1973 through 1985, imports ranged from 904 billion cu. ft. to 1,253 billion cu. ft.. As a percentage of total supply they range from 4.1% in 1974 and 1981 to 5.5% in 1979. The average was 4.5% of total supply. Imports fell to 749 billion cu. ft. in 1986, only 4% of total supply. This was the lowest level of imports since 1969.

Import prices have been higher than domestic prices, and therefore there was no great incentive to increase import volumes. However, Canada has recently adjusted price to be more competitive in the U.S. market, and is taking steps to promote increased exports to the U.S..

NGL production has not fallen at the same pace as gas production. Marketed production of natural gas in 1985 was down 24.1% from 1973. However, NGL production in 1985 was 1.609 million b/d, down only 7.4% from 1973. Natural gas production fell another 2.3% in 1986 and NGL production fell 3.6%.

Over the 1973-1985 period, the extraction rate had been on the rise. The quantity of gas processed has fallen 32%, but the extraction rate has improved substantially. The volume of natural gas liquids recovered per mcf has increased from 1.353 gallons in 1973 to an estimated 1.850 gallons in 1985. This is an increase of 37.4% in the liquid extraction level. The level of extraction is tied to the relative value of the liquids versus the value of the natural gas with a higher liquids content. The sharp drop in prices in 1986 resulted in a lowering of the extraction rate for NGL.

OUTLOOK

TO A GREAT EXTENT, natural gas has become the swing fuel source in the energy market. The inablility of natural gas to adjust to rapid price movements has often, in recent years, placed it at a competitive disadvantage.

Over the forecast period, natural gas is expected to face a great deal of competition from competing fuels. The

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drop in crude oil prices has substantially increased the competition from distillate and residual fuel oil. Coal already has a price advantage in many areas and is expected to sustain it during the forecast period.

It is not expected that the natural gas market will be able to react fast enough in response to the increased competition. The structure of the industry with substantial price regulation makes it less responsive to market changes.

The natural gas industry is beginning to become more aggressive in marketing, and this will help it to sustain existing markets. But prices are presently high, relative to competing fuels, and this will prevent gas from capturing new markets. Natural gas prices are projected to hit bottom in 1987 at an average wellhead price of $1.60/mcf. Prices are expected to increase gradually over the forecast period as other energy costs rise and as the deliverability surplus is diminished. The increase in price will be less than for crude oil, and this will prevent deterioration of the natural gas markets. Prices will move up 37.5% to $2.20/mcf in 1992. The wellhead price of crude oil is expected to increase 48.1% over the same period. As the price advantage over heavy fuel oil increases, new markets will open up to natural gas. This will also diminish gas to gas competition.

"Over the remainder of the forecast period, growth in economic activity and energy demand is expected to increase."

During the initial years of the forecast period demand for natural gas is expected to decline further, even though increased economic activity is expected. Natural gas, as the swing fuel, will provide fuel for utilities and heavy industry only when there are insufficient suppplies from other sources. With substantial growth in energy from nuclear and coal, natural gas needs will fall in 1988 and 1989. Demand is expected to slide another 2.2% to 15,810 billion cubic feet in 1989.

Over the remainder of the forecast period, growth in economic activity and energy demand is expected to increase. But growth in other competing energy sources is expected to slow. A widening gap for natural gas will develop. In addition, repeal of the Fuel Use Act should enable natural gas to compete more effectively in the utility and heavy industry markets. This should help boost demand somewhat. Demand for natural gas is therefore projected to move up to 16,580 billion cu. ft. in 1992. This is an increase of 4.9% from 1989 and 2.5% from 1987.

This is not a substantial increase. But even to achieve this level of increase prices will have to remain competitive. It is estimated that more than 40% of the gas market, possibly 6 to 8 trillion cu. ft., are in the swing market. This is a market with the ability to switch to other energy sources. Therefore, it is expected prices will be held at a competitive level. At these low prices imports are not expected to increase much over the forecast period. Imports are expected to move up marginally over the forecast period. Imports are projected to increase 7.9% to 820 billion cubic feet in 1992. With a domestic deliverability surplus, there is not a great deal of pressure to increase imports.

The deliverability surplus should

THE OUTLOOK—NATURAL GAS

	1986	1987	1988	1989	1990	19	1992	Change 1987 to 1992	% change 1987 to 1992
NATURAL GAS VOLUMES:									
(billion cubic feet)									
Marketed production	16,809	16,850	16,750	16,500	16,940	17,100	17,250	400	+ 2.4
Imports	754	760	760	760	780	800	820	60	+ 7.9
Demand	16,003	16,170	16,060	15,810	16,230	16,400	16,580	410	+ 2.5
SECTOR DEMAND:									
(billion cubic feet)									
Residential	4,404	4,430	4,440	4,440	4,480	4,520	4,550	120	+ 2.7
Commercial	2,348	2,340	2,330	2,300	2,320	2,350	2,380	40	+ 1.7
Industrial	5,226	5,170	5,170	5,160	5,200	5,250	5,280	110	+ 2.1
Electric utilities	2,602	2,800	2,700	2,570	2,800	2,840	2,920	120	+ 4.3
Pipeline & plant fuel	1,423	1,430	1,420	1,400	1,430	1,440	1,450	20	+ 1.4
Total demand	**16,003**	**16,170**	**16,060**	**15,810**	**16,230**	**16,400**	**16,580**	**410**	**+ 2.5**
PRICE:									
U.S. wellhead price									
($-per thousand cubic feet)	1.87	1.60	1.65	1.70	1.90	2.10	2.20	0.60	+ 37.5
Residential price									
($ per thousand cubic feet)	5.82	5.25	5.45	5.65	6.30	6.60	6.80	1.55	+ 29.5

slowly erode over the forecast period. Exploration and drilling activity have fallen sharply, and some production is being shut-in due to the lower prices. This is expected to reduce deliverability and close the gap, particularly after 1989. Although drilling activity will increase over the forecast period, it is not expected to be sufficient to maintain a large deliverability surplus.

If more of the rigidities associated with government regulations are removed, the industry could come closer to reaching its full potential. The development of the spot market for natural gas and the increase in contract carriage are already making the natural gas industry more flexible and competitive. This will help natural gas retain its market share in the early years of the forecast period. And to gain some market share in the latter years as energy demand grows.

"If more of the rigidities associated with government regulations are removed the industry could come closer to reaching its full potential."

Natural gas liquids production is projected to decline slightly over the forecast period. Production will fall 1.9% to 1.56 million b/d in 1992. Prices are not expected to increase sufficiently to justify an increase in gas processing and liquids extraction.

NATURAL GAS

KEYS TO THE FUTURE

1. Natural gas will be the "swing fuel" meeting energy needs not provided by other types of energy.

2. Natural gas demand will continue to fall through 1989, losing market share to other fuels. But demand will then move up over the 1990-1992 period as overall energy needs increase.

3. Imports will increase but will not capture a significant additional share of demand.

4. The greastest increase in demand will be in the electric utility sector, from 1990-1992. Consumption of electricity is expected to move up steadily.

5. Natural gas prices will move up over the forecast period but at a slower pace than crude oil.

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Other Energy Sources

THE NEED FOR ENERGY TO FUEL ECONOMIC GROWTH is the basis for any projection of demand and supply in the oil and gasindustry. Energy is required if there is ongoing economic activity. However, the amount of energy and the source of energy is constantly changing.

The quantitative relationship between economic growth and energy growth has changed markedly, since the price of oil and other energy increased rapidly in the 1970's. In addition, there has been a marked shift in the relative share of energy coming from major sources. In recent years, oil and natural gas have been losing market share to other basic energy sources; coal, nuclear, hydro, geothermal and others.

Oil and natural gas are still the dominant energy source and combined, supply almost two-thirds of the U.S. energy needs. But they do not satisfy all energy needs. Petroleum and natural gas are in fact, to a large extent the "swing" fuels, satisfying energy needs not met by other fuels. This is particularly true with respect to energy for electrical generation and for heavy industry. Those sectors of the economy look to natural gas and petroleum only when there is insufficient energy available from cheaper fuel sources, such as coal, hydroelectric and nuclear. This has been particularly true since the 1970's after the price of petroleum skyrocketed, and natural gas prices followed.

Petroleum does have its secure niche as a liquid fuel for transportation, a role that does not appear to be threatened. In fact, most long-range forecasts do not see any major economic alternative for petroleum as a transport fuel. But even in this section, some alternatives have been introduced. Automobiles and small trucks have been converted to use propane, and there is continuous experimentation with electric cars for short-range city transport.

Natural gas is carving out a substantial part of the home heating market. It has a definite advantage as a clean-burning efficient fuel. But it must remain price competitive since there are fuel alternatives. The sharp drop in crude oil prices made a competitive energy market even more competitive. At lower prices, oil products proved to even be competitive with coal as a basic energy source for utilities and heavy industry. And this drop in prices forced a decline in natural gas prices.

Even though crude prices have moved up slightly in 1987, the basic economics of energy supply have changed. Lower prices slow the conservation effort. And the lower cost of petroleum and natural gas considerably changes the financial economics of investing in capital equipment for conversion to other fuels. It lengthens the pay-back period on the increased capital investment. In many cases conversion has become uneconomical. With these changes in the economics of energy supply, it is important to look at expectations for the supply and demand for other energy sources.

"The quantitative relationship between economic growth and energy growth has changed markedly, since the price of oil and other energy increased rapidly in the 1970's."

REVIEW

TRENDS IN ENERGY. Two major factors have had the mostimpact on the energy market; the price/cost of energy and theshift to a service oriented economy. These two factors have

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ELECTRICITY GENERATION AND FUEL CONSUMPTION

	Total electricity generated (Billion kwh)	Fuels consumed: Coal (1,000 st)	% of total	Petroleum (1,000 bbl)	% of total	Natural gas (Bcf)	% of total	Nuclear, hydro & other % of total
1974	1,867.1	39[illegible]1	44.4	536,274	16.1	3,443.4	17.1	22.4
1975	1[illegible]	[illegible]62	44.5	506,128	15.1	3,157.7	15.6	24.8
1976	2[illegible]	371	46.4	555,920	15.7	3,080.9	14.4	23.5
1977	2[illegible]	[illegible]6	46.4	623,705	16.9	3,191.2	14.4	22.3
1978	2,2[illegible]	[illegible]	44.2	635,839	16.6	3,188.4	13.8	25.4
1979	2,247	[illegible]	47.8	523,297	13.5	3,490.5	14.7	24.0
1980	2,286.4	[illegible]	50.8	420,214	10.8	3,681.6	15.1	23.3
1981	2,294.8	[illegible]97	52.4	351,111	9.0	3,640.2	15.1	23.5
1982	2,241.2	593,666	53.2	249,771	6.6	3,225.5	13.6	26.6
1983	2,310.3	625,211	54.5	245,497	6.3	2,910.8	11.9	27.3
1984	2,416.3	664,399	55.5	204,479	5.0	3,111.3	12.3	27.2
1985	2,469.8	693,841	56.8	173,414	4.1	3,044.1	11.8	27.3
1986	2,487.3	685,056	55.7	230,482	5.5	2,602.4	10.0	28.8

Source: Energy Information Administration

ELECTRIC SECTOR: RELATION TO TOTAL PRODUCT DEMAND

	Total coal consumption (1,000 short tons)	Coal consumed in electric generation (1,000 short tons)	%	Total petroleum consumption (1,000 b/d)	Petroleum consumed in electric generation (1,000 b/d)	%	Total natural gas consumption (Bcf)	Natural gas consumed in electric generation (Bcf)	%
1973	562,584	389,212	69.2	17,308	1,535	8.9	22,049	3,660.2	16.6
1979	680,524	527,051	77.4	18,513	1,433	7.7	20,241	3,490.5	17.2
1986	803,831	685,056	85.2	16,281	631	3.9	16,003	2,602.4	16.3

Source: Energy Information Administration

COAL PRODUCTION

	Production	Consumption	Imports	Exports
	(1,000 short tons)			
1974	610,023	558,402	2,080	60,661
1975	654,641	562,640	940	66,309
1976	684,913	603,790	1,203	60,021
1977	697,205	625,291	1,647	54,312
1978	670,164	625,225	2,953	40,714
1979	781,134	680,524	2,059	66,042
1980	829,700	702,729	1,194	91,742
1981	823,775	732,628	1,043	112,541
1982	838,111	706,910	742	106,277
1983	782,091	736,671	1,271	77,772
1984	895,921	791,291	1,286	81,483
1985	883,638	817,925	1,952	92,680
1986	888,155	803,831	2,212	85,518
% chg 86/74	+45.6	+44.0	+6.3	+41.0

Source: Energy Information Administration

greatly influenced the quantity and type of energy consumed.

Petroleum prices first and then natural gas prices moved up substantially over the 1973-1984 period. All energy followed and became more expensive. This increase in energy costs for these basic energy sources made it economically attractive to conserve energy and to switch to other energy forms. It became economically attractive to invest in capital equipment that would reduce energy consumption. And it became cost effective to invest in equipment to establish multi-fuel capability so that large fuel users could select the least costly fuel.

In addition, the economy was in a transition to a more service-oriented and automated economy. This newly evolving economy is less energy intensive than an economy dominated by heavy industry. In addition, there is an accompanying shift toward more electrical power consumption.

Conservation led to less energy consumption per unit of economic activity. Actually, energy consumption per unit of GNP has been falling continuously since 1970. But the increase in prices accelerated the reduction. Energy consumed per unit of GNP fell 27.7% between 1970 and 1986 and is still falling. The total amount of energy consumed peaked in 1979 at 78,898 trillion BTU. It fell 10.7% to 70,495 trillion BTU in 1983. It has been oscillating up and down since. It moved up to 74,064 BTU in 1984, down to 73,962 BTU in 1985, and down to 73,873 BTU in 1986. It is estimated at 74,720 BTU in 1987. Between 1979 and 1986 GNP increased

15.1% while energy demand to fuel the increased economic activity fell 6.4%.

There was a substantial shift in energy market shares from the year of peak energy consumption, 1979, to 1985. Petroleum's share fell from 47.1% to 41.8%. The share from natural gas fell from 26.2% to 24.1%. Coal moved up from 19.1% to 23.6%. Hydroelectric and geothermal moved up from 4.1% to 4.9%, and nuclear power increased from 3.5% to 5.6% of the energy market.

Due to the sharp drop in crude oil prices, there was a temporary shift in market shares in 1986. Petroleum captured 43.4%, coal moved to 23.3%, natural gas fell to 22.3%, nuclear moved up to 6.1% and hydro and others 4.9%.

Petroleum is not expected to hold onto that market share at the higher prices. Estimates of market share for 1987 are petroleum, 42.9%; natural gas, 22.3%, coal, 23.3%, nuclear, 6.4% and hydro and others, 5.1%.

"Demand has gone up in all sectors of the economy. But growth has been greatest in the commercial sector, reflecting the shift to a service economy."

ELECTRICAL ENERGY. One of the more consistent and long-term trends in energy has been the growth in the consumption of electrical energy. The percentage of total energy that is input for the electric utility industry has been steadily increasing for years.

Just following World War II, in 1947, only 12.9% of U.S. energy consumption went for generation of electrical power. By 1961, it was up to 18.8%, and in 1971 it was up to 25.2%. It climbed up to 33.5% in 1981 and was 36% in 1986. Over one-third of all energy consumed is used for electric power generation and the percentage is increasing.

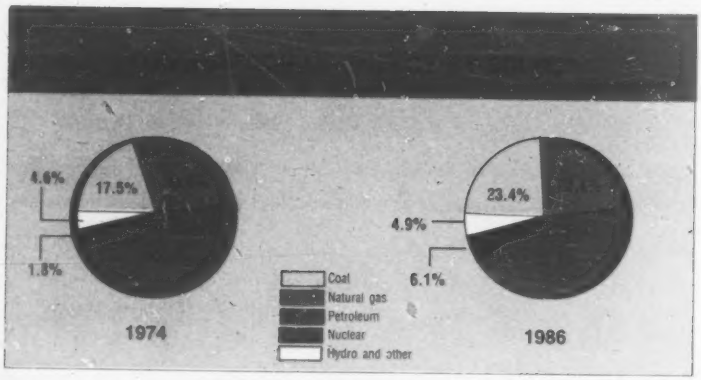
This upward trend to a higher percentage of energy for electrical power will continue for the forseeable future. The economy is shifting to more service- and information-oriented activity and industry is shifting toward more automation. Both of these movements call for energy in the form of electricity.

Net electricity generation at electric utilities has moved up in every year but one since 1973. Net electricity generated in 1973 was 1,860.7 billion kilowatt-hours. This increased 33.7% to 2,487.3 billion kilowatt-hours in 1986. This is an average annual growth rate of about 2.25% per year.

Demand has gone up in all sectors of the economy. But growth has been greatest in the commercial sector, reflecting the shift to a service economy. Commercial demand has increased 66.5% from 1973-1986. Residential demand has increased 42.6% and industrial demand has moved up 19.2%. Electrical energy is produced using all of the basic forms of energy: petroleum, natural gas, coal, hydro, nuclear, geothermal and others.

Coal has been and continues to be the primary fuel source for electrical utilities. In 1973, coal accounted for 43.6% of the fuel for electric power generation. This moved up to 54.9% in 1985. But it lost a portion of its utility market share in 1986, due to the extremely low oil prices, and fell slightly to 54.2%. With the increase in oil prices coal is expected to recapture its previous market share of electrical generation.

Total coal consumption is mostly



NUCLEAR POWER PLANT OPERATIONS

	Number of reactors	Electricity generated (Million net kwh)	% of total electricity generated	Net summer capability (Million net kw)	Capacity utilized (%)
1974	48	113,976	6.1	31,803	47.9
1975	54	172,505	9.0	37,161	56.0
1976	61	191,104	9.4	43,657	54.9
1977	65	250,883	11.8	46,202	63.4
1978	70	276,403	12.5	50,709	64.7
1979	68	255,155	11.4	49,630	58.5
1980	70	251,116	11.0	51,668	56.4
1981	74	272,674	11.9	55,914	58.4
1982	77	282,773	12.6	59,927	56.7
1983	80	293,677	12.7	63,009	54.4
1984	86	327,634	13.6	69,652	56.3
1985	95	383,691	15.5	75,397	58.0
1986	100	414,038	16.6	85,241	56.9
% chg 86-74	+108.3	+263.3	—	+168.0	—

Source: Energy Information Administration

ELECTRICITY SALES

	Residential	Commercial	Industrial	Other	Total
			(Million kwh)		
1974	578,184	384,826	684,875	58,039	1,705,924
1975	588,140	403,049	687,680	68,222	1,747,091
1976	606,452	425,094	754,069	69,631	1,855,246
1977	645,239	446,514	786,037	70,571	1,948,361
1978	674,466	461,163	809,078	73,215	2,017,922
1979	682,819	473,307	841,903	73,070	2,071,099
1980	717,495	488,155	815,067	73,732	2,094,449
1981	722,265	514,338	825,743	84,756	2,147,103
1982	729,520	526,397	744,949	85,575	2,086,441
1983	750,948	543,788	775,999	80,219	2,150,955
1984	777,654	578,281	840,588	81,849	2,278,372
1985	790,977	608,968	824,523	85,075	2,309,543
1986	825,730	646,615	818,005	86,549	2,376,898
% chg 86-74	+42.8	+68.0	+19.4	+49.1	+39.3

Source: Energy Information Administration

dependent upon electric utility demand. Coal consumption has been rising rather steadily over this period of energy fluctuation. Coal consumption moved up from 562.6 million short tons in 1973 to 818 million in 1985, an increase of 45.4%. Consumption declined slightly in 1986, falling to 804.4 million short tons, down 1.7%.

Coal consumption varies with economic activity, but increased consumption by electric utilities continues to pushup demand. Coal consumed by electric utilities increased 783%, from 389.2 million short tons in 1973 to 693.8 million short tons in 1985. The percentage of total coal consumed in electric generation increased from 69.2% in 1973 to 84.8% in 1985. Over this period, coal consumed by utilities moved up 305 million short tons. Total coal consumption moved up only 255 million short tons. Obviously, the long-run growth in coal consumption is dependent upon the growth in electrical generation.

However, coal does face potential competition, even for electrical power generation. When oil prices dropped to the extremely low levels during mid-1986, coal lost some of the utility market to petroleum. As a result, coal consumption by electric utilities fell 8.8 million short tons to 685.1 million short tons. Total coal consumption fell 13.7 million short tons. Coal consumption by industrial coke plants also fell in 1986, dropping 5.1 million short tons.

Nuclear power's share of total electrical power generation has also been rising steadily. Nuclear power's share of total energy for electrical generation increased from 4.6% in 1973

to 16.8% in 1986.

The number of operable nuclear reactors increased from 39 at year-end 1973 to 100 at the end of 1986 and up to 103 by mid-1987. The peak capacity defined as "net summer capacity of operable reactors" moved up from 22,615 million net kilowatts in 1973 to 85,241 at year end 1986, and 89,329 in mid-1987. Electricity generated increased from 83.5 million net kilowatt-hours in 1973 to 414 billion net kilowatt-hours in 1986, an increase of 396% in electrical power generated.

Although the power generated by nuclear facilities has steadily increased along with the capacity, the utilization rate of the reactors has fluctuated. The percentage of capacity utilized has fluctuated from a low of 47.9% in 1974 to a high of 64.7% in 1978. After the Three Mile Island incident, the utilization rate decreased. Concerns for safety increased the amount of time the reactors were shut down for maintenance and safety checks. The rate fell to 54.4% in 1983. It was 56.3% in 1984, 58% in 1985 and 56.9% in 1986. It is felt that there is considerable room for improvement in the utilization rate. Additional power could be generated without new facilities if the rate was increased. Hydroelectric power supplied 12.7% of energy for electric power generation in 1986. The hydro share depends upon weather conditions such as rainfall and snowfall in certain regional areas. Hydropower hit a peak in 1983 at 3,838 trillion BTU. This was 15.4% of energy for electric power that year.

"The number of operable" nuclear reactors increased from 39 at year-end 1973 to 100 at the end of 1986 and up to 103 by 1987.

The natural gas share of energy consumed for electrical power generation fell from 18.9% in 1973 to 10.1% in 1986. Over that period, the volume of gas consumed by electric utilities fell 29%. The volume fell from 3,660 billion cubic feet in 1973 to 2,602 billion cubic feet in 1986. This decline accounted for 17.5% of the overall drop in natural gas consumption from 1973-1986. There was a loss of 442 billion cubic feet in 1986 as natural gas lost market share in the utility sector to low-cost heavy fuel oil. The share of natural gas consumed by electric utilities has not changed that much falling from 16.6% in 1973 to 16.3% in 1986.

The largest drop in natural gas consumption was in the industrial sector. Industrial natural gas consumption fell 39.9% from 8,689 billion cubic feet in 1973 to 5,226 billion cubic feet in 1986. This was a drop of 3,463 billion cubic feet. It accounted for 57.3% of the decline in natural gas consumption.

Conservation, fuel switching and an economic shift away from heavy industry all contributed to the decline. The petroleum contribution to electric power generation fell from 7.7% in 1973 to 4.1% in 1985. It moved up to 5.4% in 1986 as the energy input from petroleum increased 33.2%. In 1986, heavy residual fuel oil fell to a price that was competitive with natural gas and even coal in electrical power generation. The electrical utilities with multifuel capablitiy shifted to residual fuel consumption.

The volume of oil consumed in electric power generation fell 69% from 560 million barrels in 1973 to 173 million barrels in 1985. But it rebounded last year to 230 million barrels. The drop in petroleum used for power

generation is the major reason for the decline in heavy residual fuel oil consumption. The share of total petroleum consumption for electrical power generation fell from 8.9% in 1973 to 3.0% in 1985. It moved up to 3.9% in 1986.

As the economy continues to shift toward services and automation, electrical power demand is expected to continue to increase. The resurgence of petroleum in 1986 was only temporary, however. Other energy is expected to supply the growth in electrical power consumption in the future.

"Nuclear power generation is projected to lead the way in additional electrical power output."

OUTLOOK

ECONOMIC ACTIVITY IN THE U.S. is projected to increase at an average annual rate of 2.5%–3.0% over the forecast period. Real GNP is expected to be up 14%–15% by 1992.

Energy conservation is expected to continue. And the economy is expected to continue its shift toward less energy-intensive service industries and away from energy-intensive heavy industry. The result will be a continued improvement in energy efficiency over the forecast period. The energy consumed per real GNP dollar is expected to decline another 5% to 6% by 1992. By the end of the forecast period, 33% less energy will be required per dollar of real GNP than in 1970.

All forms of basic energy are expected to post an increase in consumption over the forecast period. The type of energy consumed will be influenced most by the projected increase in electrical power demand. The shift toward a more service-oriented and automated economy will boost demand for electrical power. Electrical power consumption is projected to increase at close to twice the rate of total energy. The growth in electrical power generation will be fueled mainly by nuclear energy, coal and to a lesser extent hydro power. Therefore, the coal and nuclear share of electrical energy and of total energy will be on the increase over the forecast period.

Electrical power generation is projected to increase 14.2% by 1992, to 2900 billion kilowatt hours. Total energy demand is expected to increase only 7.6%.

Nuclear power generation is projected to lead the way in additional electrical power output. Electrical power generation from nuclear plants is expected to increase 26.6% over the forecast period. Nuclear plant capacity is projected to increase 21.3%. And the remainder of the increase will be due to an improvement in the utilization rate of nuclear capacity. Nuclear power will contribute 7.6% of all energy in 1992, up from 6.4% in 1987.

The extent of growth in nuclear power generation beyond the forecast period is in doubt. Long-range growth of nuclear power has become a political and environmental consideration more than an economic decision. Concern about the safety of nuclear facilities has almost halted the growth in nuclear capacity beyond the forecast period. With lead times of ten years or more for planning and construction of new facilities, increased capacity cannot be expected in the forseeable future. However, additional output can be obtained if plant efficiency improves

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and the utilization rate of existing facilities moves up.

With an expected increase in electrical power demand, coal consumption will also increase over the 1988-1992 period. Coal consumption will increase 9.4% over the period to 885 million short tons. Coal consumed by the electric utility industry is projected to increase to about 760 million short tons from about 692 million in 1987. In 1992 about 86% of all coal will be consumed by electric utilities.

The one issue that may cloud the longer range outlook for the increase in coal consumption is acid rain. If environmental concerns add a lot to the cost of using coal, it could lose some of its competitive price advantage over petroleum and natural gas. In that case, its growth would be slowed. But over the five-year forecast period, it is not expected to be a major concern.

Basic energy from coal will increase at about the same rate, up 9.2% to 18,985 trillion BTU in 1992. Coal's share of the total energy market will increase to 23.6% in 1992, from 23.3% in 1987.

Hydro and geothermal energy capacity is not expected to increase much over the forecast period. Hydropower will be dependent upon changing weather conditions. However, expectations are that energy from hydro and other sources will increase about 2.6% over the forecast period to 3,900 trillion BTU in 1992. Its share of the energy market will fall to 4.9% from 5.1% in 1987.

Lower oil and natural gas prices could make these fuels more competitive in the electrical power generation market. However, they are not expected to make much headway until the growth in nuclear generation slows and coal expansion becomes a major environmental issue. This may start to occur late in the forecast period.

The growth in demand for petroleum energy is expected mainly in economic sectors where it has an advantage as a liquid fuel, and in sectors such as petrochemicals where it is an important feedstock. Petroleum energy consumption is expected to increase 7.1% to 34,295 trillion BTU in 1992. Its share of the energy market will dip to 42.6% from 42.9% in 1987.

Natural gas is expected to lose market share over the forecast period. Demand for natural gas is expected to fall during the first two years of the forecast period 1988 and 1989. It is then expected to move back up through the latter part of the period 1990-1992. Energy from natural gas is projected to fall 2.2% from 1987 to 1989. Its share of the energy market is expected to fall to 21.5%, from 22.3% in 1987.

Over the next three years, natural gas demand is expected to increase marginally. It's share of the market will continue to fall, however, to 21.3% in 1992. As energy needs increase due to a faster rate of economic growth during the latter part of the forecast period 1990-1992, an energy gap will develop that will be filled by increased natural gas consumption. Although nuclear power and coal energy will be increasing, environmental concerns will prevent expansion at a rate fast enough to fill all the new energy needs.

Beyond the forecast period it should be noted that providing adequate

"The one issue that cloud the longer range outlook for the increase in coal consumption is acid rain."

THE OUTLOOK—OTHER ENERGY SOURCES

	1986	1987	1988	1989	1990	1991	1992	Change 1987 to 1992	% change 1987 to 1992
ENERGY DEMAND (trillion BTU)									
Petroleum	31.887	32.035	32.310	32.520	33.155	33.790	34.295	2.260	+ 7.1
Natural gas	16.531	16.690	16.585	16.330	16.765	16.940	17.120	430	+ 2.6
Coal	17.271	17.385	17.600	17.865	18.135	18.640	18.985	1.600	+ 9.2
Nuclear	4.475	4.810	5.145	5.455	5.730	5.970	6.100	1.290	+ 26.8
Hydro and other	3.709	3.800	3.830	3.860	3.890	3.900	3.900	100	+ 2.6
Total energy demand	**73.873**	**74.720**	**75.470**	**76.030**	**77.675**	**79.240**	**80.400**	**5.680**	**+ 7.6**
Coal consumption (million short-tons)	804	809	820	830	845	865	885	76	+ 9.4
Electricity generation (billion kilowatthours)	2.487	2.540	2.590	2.630	2.740	2.820	2.900	360	+ 14.2
Nuclear capacity (million kilowatts)	85	89	96	101	105	107	108	19	+ 21.3
Nuclear generation (billion kilowatthours)	414	470	510	540	560	580	595	125	+ 26.6

electrical power to meet the growing demand may become a serious issue. The two major sources of energy for electrical power generation are coal and nuclear power. Both of these sources are under attack from groups concerned about nuclear power dangers and potential pollution. An opportunity could develop at that time for another surge in demand for petroleum and/or natural gas.

OTHER ENERGY SOURCES

KEYS TO THE FUTURE

1. To fuel economic growth over the forecast period, energy consumption will move up steadily, and be 7.6% higher by 1992.

2. The shift to a more service-oriented economy in the U.S. will result in a growing demand for electrical power, up 14.2% by 1992.

3. To help provide for the increased consumption of electricity, energy from nuclear power will increase 26.8% by 1992, moving up much faster than other energy sources.

4. Coal consumption will increase 9.4%, also stimulated by the increase in electrical power demand.

5. Increased electric utility demand for natural gas and petroleum could occur late in the forecast period if environmental issues restrict the growth of coal and nuclear power.

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countries is expected to grow less than half as fast as economic activity between 1985 and 1990 and to remain relatively flat in absolute terms thereafter. In the developing countries, oil consumption is expected to grow between a quarter and a third as fast as economic activity in the 1990's."

"OPEC is obviously projected as filling the gap between declining production in the non-OPEC countries, and rising demand."

In the base case, the U.S. oil consumption is projected to move up slowly to 16.5 million b/d in 1995 and 17.4 million b/d in 2000. This is a growth rate of only about 0.5% per year through 1995. The growth rate moves up to a little over 1% per year from 1995-2000. The low and high cases show a range of 15.5-17.5 million b/d for 1995 and 16.3-18.7 million b/d for 2000.

For all of the OECD countries, including the U.S., demand is projected at 50.4 million b/d in 1995 and 51.3 million b/d in 2000, for the base case. The growth rate up to 1995 is about 0.8% per year. This slows to about 0.3% per year from 1995-2000. Considering the low and high price cases, the range for demand is 47.4-54 million b/d in 1995 and 47.4-55.5 million b/d in 2000. Under the high price case there is no growth in oil demand in the total market economies over the 1995-2000 period.

The supply side projects increasing OPEC production and sliding non-OPEC production over the forecast period. OPEC production is expected to move up substantially over the forecast period. OPEC total liquids output is projected at 22.9 million b/d in 1990, 26.4 million b/d in 1995 and 28.3 million b/d in 2000.

Non-OPEC production is projected at 25.2 million b/d in 1990, 23.2 million b/d in 1995 and 22.6 million b/d in 2000. Imports from the communist countries are also projected as falling over the forecast period. It will fall to 1.4 million b/d in 1990, 900,000 b/d in 1995 and only 500,000 b/d in 2000.

OPEC is obviously projected as filling the gap between declining production in the non-OPEC countries, and rising demand. By 1990, a large portion of the OPEC surplus capacity will have been eliminated, and by 1995 most of the OPEC excess capacity will be gone. Somewhere after 1990, OPEC will be in a position to boost prices substantially.

U.S. total liquids production is projected to fall to 9.4 million b/d in 1990. It will continue to decline rapidly, dropping to 8.3 million b/d in 1995 and 7.7 million b/d in 2000. This is one of the major reasons for declining non-OPEC production. It also indicates a growing need in the U.S. for imported oil. By the year 2000, the difference between U.S. consumption and domestic production is projected at almost 10 million b/d. U.S. dependency on foreign oil will be growing rapidly.

The EIA forecast also projects a substantial increase in natural gas consumption over the forecast period. In the base case, natural gas is projected to provide about 18.5% of total non-communist energy from now through 1990. Consumption will then increase more rapidly than that for total energy and it will increase to 20.7% of total energy by 2000. Consumption in absolute terms will increase from 37.1 trillion cu. ft. in 1985 to 40.6 trillion

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cu. ft. in 1990 and 53.6 trillion cu. ft. in 2000. The growth rate through 1990 is about 1.8% per year. This escalates to an average 2.8% per year from 1990-2000.

Two thirds of the growth projected will be in the developing countries. Consumption in these areas is expected to increase from 7.2 trillion cu. ft. in 1985 to 9.6 trillion cu. ft. in 1990 and 18.4 trillion cu. ft. in 2000. According to EIA, "consumption of natural gas may be encouraged by the availability of domestic reserves which if exploited, could conserve oil reserves or reduce oil imports, fuel-switching due to environmental considerations favoring natural gas over less clean-burning fuels, and technological innovations such as natural gas air conditioning systems." This appears to be the case for many of the developing countries.

Natural gas consumption in the U.S. is projected to move up only marginally to 17.9 trillion cu. ft. in 2000. This is an average annual growth rate of only 0.2%.

Consumption in Europe is projected to increase at a greater rate, moving up 1.9% per year through 2000 to 11.3 trillion cu. ft. This is an increase of 2.8 trillion cu. ft. from the consumption level in 1985.

"Two-thirds of the growth projected will be in the developing countries."

Reflecting on the potential in the industrial countries, particularly the U.S., the EIA forecast stated, "the existence of mature markets with little room for expanding the number of gas customers, concerns about supply security where domestic reserves are either limited or nonexistent, the availability of expanded coal or nuclear power generation capacity, and improvements in energy efficiency could limit, or in some cases reduce, the future consumption of natural gas."

SALOMON BROTHERS

THE INVESTMENT FIRM OF SALOMON BROTHERS INC., issued a report in May 1987, projecting worldwide demand and supply of oil, and prices through 1990.

In this report, Salomon Brothers projected the average yearly price of West Texas Intermediate Crude Oil futures on the New York Mercantile Exchange. This price differs from the posted price for West Texas Intermediate (WTI) and also differs from the average price for all types of crude. The WTI price is generally at least $3 higher than the average wellhead price. They project that the WTI price will move up to $24/bbl in 1990 from an average $18.50/bbl in 1987. This would be an increase of 29.7% over this three year span.

Salomon Brothers projected non-communist economic growth to average 2.5% per year from 1988-1990. Due to conservation and substitution they project that demand for energy will be growing at a rate of 1.2–1.5% over the 1988-1990 period.

They project that non-communist oil demand will increase from 47 million b/d in 1987 to 48.9 million b/d in 1990, up 4%. U.S. demand will increase at a slightly slower rate, 3.6%, from 16.5 million b/d in 1987 to 17.1 million b/d in 1990. Western European demand will be even more sluggish increasing 3.3% from 12.1 million b/d to 12.5 million b/d. Demand in the developing countries, including OPEC,

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HIGHLIGHTS
ENERGY INFORMATION ADMINISTRATION
(BASE CASE)*

	1985	1986	1987	1990	1995	2000
World oil prices: (Dollars/barrel)						
Nominal price	26.99	14.57	16.00	21.00	40.00	64.00
Real price (1986 $)	27.64	14.57	15.00	18.00	27.00	33.00
Energy consumption: (Quadrillion BTU)						
United States	73.9	—	—	78.6	83.1	87.3
OECD Countries	157.1	—	—	170.2	181.0	190.8
Total market economies	205.0	—	—	225.0	245.0	265.0
Oil consumption: (Million barrels/day)						
United States	15.7	16.1	16.3	16.1	16.5	17.4
OECD countries	34.3	35.2	35.7	36.1	36.5	36.5
Developing countries	12.1	12.3	12.6	13.3	13.9	14.8
Total market economies	46.4	47.5	48.3	49.4	50.4	51.3
Oil production: Total liquids (Million barrels/day)						
United States	11.2	10.9	10.3	9.4	8.3	7.7
Non-OPEC	26.7	26.6	26.3	25.2	23.2	22.6
OPEC	17.2	19.4	19.3	22.9	26.4	28.3
Natural gas consumption (Trillion cubic feet)						
United States	17.3	—	—	17.5	18.0	17.9
OECD countries	29.9	—	—	31.0	33.4	35.2
Developing countries	7.2	—	—	9.6	13.8	18.4
Total market economies	37.1	—	—	40.6	47.2	53.6

*Economic growth rates: U.S. 2.5% 1985-2000
Market economies 2.7% 1985-1990
2.9% 1990-2000

HIGHLIGHTS
SALOMON BROTHERS INC.—OUTLOOK

	1985	1986	1987	1988	1989	1990
West Texas Intermediate Merc price (Dollars/barrel)	27.99	14.91	18.50	20.00	22.00	24.00
Worldwide economic growth (Annual percentage increase)	3.0	2.5	2.0	2.5	2.5	2.5
Oil demand (Million barrels/day)						
United States	16.0	16.3	16.5	16.7	16.9	17.1
Western Europe	11.6	12.1	12.1	12.2	12.4	12.5
Japan and other industrial	6.5	6.5	6.5	6.7	6.8	6.9
Developing countries	11.5	11.7	11.9	12.0	12.2	12.4
World Total	**45.6**	**46.6**	**47.0**	**47.6**	**48.3**	**48.9**
Oil supply (Million barrels/day)						
United States	11.4	11.0	10.5	10.2	9.8	9.4
North Sea	3.6	3.7	3.7	3.5	3.4	3.3
Other Non-OPEC	11.6	11.6	12.0	12.3	12.5	12.7
Total Non-OPEC	**26.6**	**26.3**	**26.2**	**26.0**	**25.7**	**25.4**
Imports from Communist	1.5	1.9	1.8	1.7	1.6	1.6
OPEC crude production	15.9	17.9	16.9	18.4	19.6	20.5
OPEC NGL and condensate	1.3	1.4	1.5	1.5	1.6	1.6
Total OPEC	**17.2**	**19.3**	**18.4**	**19.9**	**21.2**	**22.1**
OPEC export revenues (Billion dollars)	135	80	93	111	131	149

will increase 4.2% from 11.9 million b/d to 12.4 million b/d.

On the supply side, a greater volume of OPEC oil will be needed throughout the forecast period, 1988-1990. This is apparently a major reason why prices are expected to move up over this period.

Total non-OPEC supply is expected to decline 1 million b/d over the 1987-1990 period, dropping from 28 million b/d to 27 million b/d in 1990. This supply figure includes imports from communist countries.

U.S. production is projected to fall from 10.5 million b/d in 1987 to 9.4 million b/d in 1990, a drop of 10.5%. North Sea production is projected to fall from 3.7 million b/d to 3.3 million b/d in 1990. Imports from the communist countries are also expected to fall from 1.8 million b/d to 1.6 million b/d. These declines in supply will be partially offset by increases in production in Mexico and other non-OPEC areas. Mexican production is projected to increase from 2.8 million b/d to 3.0 million b/d in 1990. Production from the remainder of the non-OPEC areas is projected to increase from 9.2 million b/d to 9.7 million b/d.

As a result of increasing demand and decreasing non-OPEC production, OPEC crude oil output is projected to move up from 16.9 million b/d in 1987 to 20.5 million b/d in 1990. This is an increase of 3.6 million b/d, 21.3% over this three-year span. In addition, OPEC will be supplying 1.5-1.6 million b/d of NGL and condensate.

With increasing export volumes and increasing prices, OPEC revenues from crude oil exports are expected to

increase rapidly. Salomon Brothers estimated OPEC export revenues at $80 billion in 1986 and $93 billion in 1987. This is expected to move up to $149 billion in 1990. However, it is still only half of the $309 billion they show for 1980.

MORGAN GUARANTY TRUST COMPANY OF NEW YORK

IN THEIR MAY 1987 "World Financial Markets" publication, Morgan Guaranty Trust Company of New York presented their oil industry outlook.

They were not as precise in their outlook and presented general statements about future expectations for economic-growth, energy demand, oil demand and oil supply.

With respect to future economic growth, they made the following statements about U.S. and OECD expectations. "Looking to the future, the reduction of the U.S. federal budget deficit now in progress is crimping U.S. domestic demand. Still, U.S. GNP growth may edge higher on the basis of improving real net exports. But, driven now mainly by the dollar's depreciation, real net export trends are a powerfully negative force on GNP for Japan and Europe. Expansionary domestic demand policies would be the proven antidote. But neither Japan nor Europe — in particular, Germany — has yet seen fit to espouse them. There is therefore little basis for visualizing OECD real GNP growth above 2.3% in 1987, or 2.5% annually during the next several years. Moreover, there now is a preponderance of downside risks in the growth outlook. It is against this subdued, even recession-prone, global economic background that oil consumers and producers must develop their strategies for the years ahead."

"As a result of increasing demand and decreasing non-OPEC production, OPEC crude oil output is projected to move up from 16.9 million b/d in 1987 to 20.5 million b/d in 1990."

With respect to overall energy demand and oil demand, they made the following pertinent comments: "More fundamental to the medium-term prospect for oil demand, is the remaining potential for energy conservation — notably in the United States and developing countries — and for fuel substitution at oil's expense — principally outside the United States —even at current oil prices. The scope for further gains in U.S. energy efficiency is evident from the example of other industrial countries. U.S. energy efficiency is prone to rise the more the economy tilts away from heavy manufacturing toward less energy-intensive activities. Compared with the conservation potential, U.S. oil substitution possibilities are smaller — although by no means exhausted."

Outside the U.S., Morgan Guaranty pointed out the following. "Substitution offers greater promises for curbing oil use in Japan and Europe than in the United States. Because of their geography, historical dependence on imported energy, and tradition of higher energy taxes, both regions have long been more efficient energy consumers than the United States. However, given that oil still meets a higher proportion of their total energy demand, both Japan and Europe have scope for further curbing their reliance on oil. Both have access to ample supplies of natural gas or coal and projects are underway to exploit them."

"In most LDCs, rapid population growth, the desire for accelerated

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economic growth, the need to switch energy consumption away from depleting traditional sources, such as wood, plus the energy-using character of modernization and development, point to a fast-rising appetite for energy, including oil. However, appetites often go unsatisfied. Actual LDC oil consumption is likely to be restrained by sluggish LDC export prospects in a slow-growing world economy, financial problems in some of the larger LDCs, and poor domestic policies in all too many cases. Further, the raising of domestic oil prices in many LDCs during the early 1980's plus their reluctance to pass on price declines for budgetary and financial reasons should contain LDC oil consumption."

"The most likely source of rapid increase in non-OPEC oil supply over the next few years will be the numerous non-OPEC LDCs that are net oil importers or modest exporters."

Summing up and quantifying these comments they projected the following. "Beyond 1987, should oil prices in real terms remain around present levels and OECD economic growth average 2.5%, oil consumption growth could run 1% - 1.5% per annum, for an additional 600,000 bpd each year on average. Should economic growth falter, the growth in oil consumption could be substantially less, or even nonexistent."

Looking on the supply side, they saw the following for U.S. production. "Depending on whether oil prices rise moderately or remain at current levels in real terms, the decline in U.S. production from end-1986 levels through 1990 could reach anywhere between 500,000 and over 1 million bpd. Higher oil prices primarily would benefit U.S. natural gas production. They would alter the degree, but not the direction, of the U.S. oil output trend."

They expect total non-OPEC oil supply to be [illegible] or at best, marginally rising in the next few years. For non-OPEC supply other than the U.S., they gave the following round up. The outlook for non-OPEC oil supply outside the United States is mixed. Some of the sources contributing most to its increase over the past decade — the North Sea, CPE net exports, and Mexico — will see much smaller increases or even declines. U.K. North Sea output is peaking and a gradual, geology-determined decline is about to set in.

Norway and Mexico have potential for further large gains in output but may hold back for policy reasons. Norway is concerned about the balance of its economy and the strains that overly rapid, yet often erratic, oil-related investment places on employment and activity in the non-oil sector. In Mexico, budgetary and financial considerations limit the state oil company's development spending. Both nations are mindful of conservation and political reasons to contain the growth of oil output, and have shown some willingness —especially Mexico — to complement OPEC restraint.

The most likely source of rapid increase in non-OPEC oil supply over the next few years will be the numerous non-OPEC LDCs that are net oil importers or modest exporters. The largest such producers at present are Egypt, India, Brazil, Oman, Malaysia, and Argentina. In the future, significant increases are expected from Colombia, North Yemen, Angola, Syria, and — to some degree — Brazil.

Although marginal individually, these countries' collective contribution

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to world oil supply may well become substantial. In the ten years to 1985, it rose almost 3.5 million bpd. It was up almost 300,000 bpd last year —nearly equaling the fall in U.S. production — and may rise another 1 million bpd by the early 1990's.

With regard to OPEC production and supply, they had the following to say: "OPEC members can expect gradual gains in their world market share for oil — initially, supplying the bulk of the increase in demand and, later, offsetting the fall in non-OPEC supply as well. At current oil prices in real terms, the bulk of future incremental oil imports, particularly by industrial countries, will be supplied by OPEC members. Their crude oil production, which is expected to average over 17 million bpd this year, may reach 20 million bpd by 1990 on an optimistic view. This outlook is the reverse of OPEC market share and output experience in the first half of the 1980's, but in line with the longer-term trend of growing world reliance on OPEC oil supply for reasons of geology and resource cost. The likelihood that the trend will reassert itself has been heightened by the 1986 fall in oil prices, notwithstanding their subsequent rebound."

Also of interest is their evaluation of the current level of oil prices. "On the whole, there is much to be said for the present level of oil prices. For the first time in fifteen years, the major consumers are expressing little objection to current prices and OPEC production policies. In the future, gradual and moderate oil-price increases in nominal terms — maintaining relative stability in real terms— would be the best way to rectify global demand/supply fundamentals for oil consistent with the economic interests of both consumers and producers. After all, large real price movements in the past — in either direction — have proven harmful for both, especially OPEC members."

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